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INTRODUCTION

Welcome to Flanker 2.0! This simulation is the result of a great amount of effort, by many people from all over this planet. A development team in Russia, a publisher with staff located in the United States and the United Kingdom, testers located in Canada, Scandinavia, Asia, the Balkans, all over Europe, and just about every point in between. This has truly been an international effort. We thank you for your purchase and hope that you enjoy this product as much as we enjoyed creating it.

FLANKER BRIEFING

The Su-27 Flanker and its descendants are some of the most impressive and capable aircraft in the world. Born in the dying days of the cold war, the Flanker did not have an easy life and the initial design suffered from serious problems. The breakup of the Soviet Union and subsequent collapse of the Russian economy hindered its development, in many ways denying the Flanker an opportunity to prove itself as the world's greatest tactical aircraft.

History of the Flanker

The aircraft's early history was so problematic that it faced outright cancellation on numerous occasions. Conceived in 1967, both the Su-27 and MiG-31 were intended as long-ranged interceptors to replace the Tu-128, Su-15, and Yak-28P aircraft. More specifically, the design required the Flanker to be capable of destroying enemy aircraft protecting enemy targets; a thinly disguised directive to best the U.S.-built F-15 in air-to-air combat. The initial prototype, the T-10-1, conducted its maiden flight on May 20, 1977. Although photographed by Western intelligence satellites, no clear pictures were available to the public until a TV documentary about the Sukhoi OKB (design bureau) displayed still pictures of the Flanker in 1985. Given the basic blended body, twin tail fins, and widely spaced engines, Western analysts inevitably pointed to the Su-27 as a copy of the Western designs found in the F-16, F-15, and F-14. In truth, the similarities seem to be common solutions to problems shared by Eastern and Western design requirements.

The program, though, quickly began to experience problems. The second prototype, number T-10-2, suffered control system failure, and the pilot was killed during ejection. By 1979, additional prototypes were flying, but the program was failing to meet its performance requirements. Drag was higher than expected, engine performance was low, fuel consumption was too high, and heavy avionics in the nose decreased stability. Further, flutter problems required the addition of anti flutter weights in the tailfins, tailplanes, and wings. By this time, information about the F-15 indicated the Flanker would be no match for the American jet in air-to-air combat. A redesign was needed.

Prototypes T-10-7 and T-10-8 were redesignated T-10S-1 and T-10S-2 and built to a substantially improved design. An entirely new wing improved lift while offsetting the weight of the equipment-packed nose. Anti-flutter weights, serving as wingtip missile launch rails, replaced the curved wingtips of the early prototypes. The fuselage received substantial modifications, fins were increased in size, and the airbrake was redesigned. The T-10S-1 first flew in 1981. Avionics problems continued to dog the program, though, and service deliveries didn't begin until 1985, roughly a decade after the F-15 entered service. One of the T-10S prototypes, redesignated as P-42, was prepared to capture numerous aviation records from the F-15. Stripped of avionics and unnecessary gear, the P-42 was fitted with modified engines and set a total of 27 world records between October 1986 and December 1988, including numerous time-to-height records.

Performance Characteristics

	T-10-1	SU-27	SU-33	SU-34	SU-35
Powerplant	2 x AL-21F3	2 x AL-31F	2 x AL-35F or AL-31MF	2 x AL35F or AL-31MF	2 x AL-35F or AL-31MF
Thrust Each Engine	11,220kg	12,522kg	14,029kg	14,029kg	14,029kg
Wingspan	14.8m	14.8m	14.8m	14.8m	15.1m
Height	5.92m	5.98m	5.95m	5.95m	6.42m
Max Takeoff Weight	25,786kg	30,000kg	30,000 kg.	44,400kg	

Flanker Variants

Most legendary tactical aircraft share a common trait: versatility. The Flanker is no exception, with numerous sub-variants arriving on the scene. Usually, aircraft variants are identified by adding a letter to the base designation (F-16A, F-16B, F-16C, etc.), Sukhoi eventually abandoned this method, giving each variant a new designation. Some speculate that this was intended to promote the idea that each variant was a whole new aircraft, hopefully improving domestic funding as well as overseas sales. Flanker operators include Belarus, Ukraine, Russia, India and China.

Su-30 – Initially called the Su-27PU, this is an improved version of the original Su-27UB two-seat trainer. Unlike the Su-27UB, the Su-30 is a fully operational combat aircraft. It is optimized for missions lasting 10 or more hours, and would normally act as an airborne mission controller.

Su-30MK - This improved version of the Su-30 is optimized for delivery of precision-guided munitions, some of which may have stand-off ranges of 120km (75 miles). The Su-30MK also features an improved navigation and weapons systems.

Su-33 – Originally designated the Su-27K, this variant is specifically designed for the demanding role of carrier-based aviation. Equipped with canards for improved take off and landing performance, the first Su-27K made its maiden flight in 1985. The shortened tailcone, intended to reduce risk of tail strike during high AOA landing, reduces the space for defensive equipment (including chaff and flare dispensers). Whereas the Su-27 was tailored primarily as an air-to-air interceptor, the Su-33 is a multi-role aircraft (a necessity of carrier based aviation operating far from home bases). The Su-33 retains to a large extent the avionics and cockpit of the basic Su-27.

Su-34 – Also known as the Su-32FN, this aircraft is a two-seat (side by side cockpit), long-range, day/night fighter-bomber, intended to replace the MiG-27, Su-17, and Su-24. The Su-34 first flew on December 18, 1993. Canards improve manoeuvreability, and an elongated tailcone reportedly houses aft facing missile guiding systems. The aircraft features an improved glass cockpit along with the traditional analog gauges. Besides having a unique ejection system and terrain following radar, the aircraft actually has a toilet and sleeping facilities onboard.

Su-35 – Originally designated the Su-27M, this multi-role variant of the Su-27 features improved avionics; a modern "glass cockpit" replacing the traditional analog gauges with multi-function displays and digital readouts. The collapse of the Soviet Union has hindered the deployment of the Su-35, prototypes of which perform routinely at international airshows.

Su-37 – Having appeared at numerous airshows, this variant is basically an Su-35 equipped with thrust vectoring engine exhausts for improved low-speed agility. Russia has stated that this will eventually become the standard operating variant.

Ready For Action

This concludes our introduction to the Flanker family, arguably the most powerful and versatile group of aircraft ever built. Chapter 2 will orient you with the simulation interface and explain how to get airborne quickly.

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QUICK START

The main menu provides several options for becoming airborne. The three quickest ways to takeoff are via the Instant Combat, Training, and Mission menu modes.

Installation

You must install Flanker 2.0 game files to your hard drive and have the Flanker 2.0 CD in your CD-ROM drive to play this game.

To install the game, insert the CD into the CD-ROM drive. When the pop-up window appears, click on the Install option. If you have disabled the Windows Autorun, or if it does not function, Explore the CD and double-click on the Setup icon. Follow all on-screen prompts to complete the installation.

What Comes with this Game?

Your game box should contain this user manual, a pilot checklist and a Flanker 2.0 CD. This user manual explains how to play and contains important information on menus, scenarios, and unit classes and equipment.

System Requirements

To play Flanker 2.0, be sure your system meets the following system requirements:

- Pentium 200 MHz IBM PC or compatible
- 32 MB of RAM
- Windows® 95 or 98 - NOTE: This is a Windows 95 game and cannot be played on Windows® NT systems. Multitasking is not recommended when playing Flanker 2.0
- An uncompressed hard drive with at least 600MB free
- 8 X CD-ROM drive or faster
- A DirectX compliant 3D accelerated video card with 4MB of memory and a Colour SVGA Monitor
- A 100% Microsoft (or Logitech) compatible mouse
- Microsoft mouse driver version 9.00 or higher or Logitech mouse driver version 6.24 or higher
- 100% DirectX Compatible Sound Card

In addition to the basic system requirements, the game requires that DirectX 6.1 be installed to your hard drive. The option to install DirectX 6.1 appears during the game installation. At the end of installation, you are prompted to register Flanker 2.0 electronically. For network play, you need a DirectPlay compatible network adapter.

Flanker 2.0 utilizes Microsoft DirectX sound and video drivers. DirectX is a programming tool created by Microsoft, and the installation of DirectX may cause video problems and system anomalies with computers using video drivers that arenít DirectX compliant. DirectX is a Microsoft product, and as such, this publisher cannot be responsible for changes that might occur to your computer system due to its installation. For DirectX related problems that cannot be fixed by updating to your video cardís latest Windows driver set, you must contact either Microsoft or the manufacturer of your video card for further technical support or service.

Microsoft retains all intellectual property rights to DirectX. The user has been granted a limited license to use DirectX with Microsoft operating system products.

Uninstalling the Game

To uninstall the game, select that option from the Autorun menu, or choose Settings from the Windows 95 Start Button, and select Control Panel. In the Control Panel, select Add/Remove Programs, left-click on Flanker 2.0,and click on the Add/Remove button. The game and all of its components are then removed from your hard drive, except for your saved games or edited scenarios.

OVERVIEW

We know you're anxious to start flying, so this chapter is divided into two portions. The first portion describes how to get through the menus quickly, how to get airborne, and how to control the aircraft. The second portion of this chapter explains each menu choice in more detail.

Su-27 vs Su-33

Flanker 2.0 lets you pilot either the Su-27 or Su-33. Your first question is probably, "What's the difference?" The Su-33 is a navalized version of the basic Flanker; an aircraft designed to operate from aircraft carriers. Whereas the Su-27 is a pure interceptor with no real secondary ground-attack role, the nature of carrier-based aviation requires the Su-33 perform both ground-attack and air-to-air duties. There may not a friendly airbase from which supporting Su-25's can launch and recover. The carrier's Su-33s will have to perform both roles.

Despite the differences in operating environments, as a Flanker pilot you will find very little difference between the two aircraft. The cockpits, controls, and avionics are virtually identical. The Su-33 is a little heavier than the Su-27. The Su-33 has more powerful engines, but this performance advantage is somewhat offset by increased fuel capacity (for longer range) and increased maximum takeoff weight. Except for the rigors of carrier takeoffs and landings, you should have little difficulty switching between the two aircraft.

Instant Combat Mode

2-1: The Four Forces of Flight

Instant Combat mode is the quickest way to get airborne and take on an opponent. It features a simplified radar and flight model. From the main menu, select "Instant Combat", then select "Air-to-Air." Check the "unlimited fuel and weapons" and the "automatic target lock-on" boxes. From the pull-down menus, select "Russia" for my country and "immortal" for my survivability.

For the enemy, select the type of aircraft you wish to fly against, select a country for it to fly for, and specify the quality of the computer controlled pilot. When you've completed configuring the scenario, select the "Run" button. You'll be placed in a Flanker with an appropriate weapons load out. The mission will generate a random number (1-6) of enemy targets. Manoeuvre toward your target and engage!

Training Mode

Training mode provides a series of pre-defined missions configured into ten categories. Each category may have several individual missions catering to specific training needs. Choose "Training" from the main menu, the select the appropriate category (Free Flight, etc.) Next, select a specific mission within that category group.

The pre-recorded training mission begins playing while the instructor pilot narrates. The instructor will walk through the mission, explaining the procedure or task step-by-step. At anytime, you may take control and complete the mission yourself by pressing the ESC key. We recommend allowing the instructor to fully describe the task and complete the narration before taking manual control. You may exit the mission by pressing the Ctrl-Q key.

2-3: The Training Mission Screen

Missions Mode

2-2: The Mission Mode Select Screen

From this menu you can review and load all saved missions available in the game, including pre-defined missions that come with the simulator as well as those you've added. You can use the mission mode to begin a campaign or simply fly an individual sortie. Simply click on the desired mission and click the Run button.

Key Commands

Now that you're in the cockpit you need to know the basic controls. The following table shows the key commands necessary to control the simulation.

PROGRAM CONTROL

KEY	ACTION
Ctrl-A	Accelerate program speed by 2 times.
Ctrl-Q	Quit program from Main Menu, also ends mission
Alt-X	Quit Mission Editor and return to Main Menu
Ctrl-S	Toggle Sound On or Off
Ctrl-T	Cancel Trim Settings
Shift-M	Reset Audible Warnings
S	Toggle Pause/Resume normal speed
Esc	Allows user to take control of aircraft while viewing a track file playback
0 (zero) [not Key Pad 0]	Turns on microphone for recording mission playback
Ctrl-L	Starts network play game from Mission Editor
Ctrl-M	Chat feature for multi-player network games

FLIGHT CONTROL

KEY	ACTION
Down Arrow	Nose up (without joystick)
Up Arrow	Nose down (without joystick)
Left Arrow	Bank left (without joystick)
Right Arrow	Bank right (without joystick)
Ctrl-. (Period)	Trim up
Ctrl-; (Semi-colon)	Trim down
Ctrl-, (Comma)	Trim left
Ctrl-/ (Slash)	Trim right
Z	Rudder left (in flight), left turn (taxi)
X	Rudder right (in flight), right turn (taxi)
Ctrl-Z	Trim left rudder
Ctrl-X	Trim right rudder
H	Toggle altitude stabilization mode
J	Toggle auto-throttle
K	Execute "Pugachev's Cobra"

THROTTLE CONTROL

KEY	ACTION
Page Up	Increase Throttle in increments (without throttle option enabled)
Page Down	Decrease Throttle in increments (without throttle option enabled)
Key Pad + (Plus)	Increase Throttle smoothly (without throttle option enabled)
Key Pad - (Minus)	Decrease Throttle smoothly (without throttle option enabled)

MECHANICAL SYSTEMS CONTROL

KEY	ACTION
B	Toggle airbrake
Shift-B	Airbrake out
Ctrl-B	Airbrake in
Ctrl-E,E,E	Eject (Note: hold down Ctrl key and hit E three times)
E	Toggle active jamming (requires ECM pods in loadout)
F	Toggle flaps up/down
Shift-F	Flaps down
Ctrl-F	Flaps up
G	Toggle landing gear up/down
Ctrl-G	Toggle arrestor hook down or up (Note: Su-33 only, not Su-27)
P	Release drogue chute (Note: Su-27 only, not Su-33)
Ctrl-P	Toggle folding wings (Note: Su-33 only, not Su-27)
L	Dump fuel (in flight) or refuel (ground) (Note: Hold down key)
W	Engage wheel brakes (ground) (Note: Hold down key)
T	Toggle wingtip smoke
Shift-M	Reset Current Audible Warning

NAVIGATION

KEY	ACTION
`	Select next waypoint or airfield
A	Toggle autopilot
1	Toggle to set Navigation (NAV) submodes

COMBAT MODES

2	Toggle to set Beyond Visual Range (BVR/DVB) submodes
3	Select Close Air Combat – Vertical Scan (CAC/BVB – VS) submode
4	Select Close Air Combat – Bore (CAC/BVB – BORE/STR) submode
5	Select Close Air Combat – Helmet-Mounted Target Designator (CAC/BVB – HMTD/SHLEM) mode

KEY	ACTION
6	Select Longitudinal Missile Aiming (LNGT/FIO) mode
7	Select Air-to-ground (GND/ZEMLYA) mode
`	Cycle through targets on MFD in AWACS and Ground Attack Modes
Tab	Place designated contact in Track While Scan from Scan
Ctrl-Tab	Remove tracked contact from Track While Scan
Tab	Lock tracked target to Attack Mode
Tab	Lock/unlock target to Attack Mode in CAC submodes
Ctrl-H	Cycle through Heads Up Display (HUD) intensities

WEAPONS

KEY	ACTION
D	Cycle through weapons selection
C	Toggle cannon
Q	Dispense chaff & flare
Shift-Q	Continuously dispense chaff & flares (Note: until supply is exhausted)
Spacebar	Fire current weapon
Ctrl+W	Jettison weapons in pairs while airborne, reloads weapons while on the ground

RADAR & ELECTRO-OPTICAL SYSTEMS

KEY	ACTION
I	Toggle radar illumination on or off
O	Toggle Electo-Optical System (EOS) or weapon TV seeker on or off
Ctrl-I	Center radar antenna/Infra-Red Scan and Track(ISRT) ball
- (Minus)	Multi-Functional Display (MFD) zoom in
+ (Plus)	Multi-Functional Display zoom out
Ctrl-V	Toggle Salvo mode on or off

BEYOND VISUAL RANGE MODE

KEY	ACTION
Shift-; (Semicolon)	Move radar/EOS scan zone DOWN while in BVR
Shift-, (Comma)	Move radar/EOS scan zone LEFT while in BVR
Shift-. (Period)	Move radar/EOS scan zone UP while in BVR
Shift-/ (Slash)	Move radar/EOS scan zone RIGHT while in BVR
; (Semicolon)	Move HUD target designator Box DOWN (BVR only)
, (Comma)	Move HUD target designator Box LEFT (BVR only)
. (Period)	Move HUD target designator Box UP (BVR only)
/ (Slash)	Move HUD target designator Box RIGHT (BVR only)

CLOSE AIR COMBAT MODE

KEY	ACTION
; (Semicolon)	Move radar/EOS scan zone DOWN while in BVR
, (Comma)	Move radar/EOS scan zone LEFT while in BVR
. (Period)	Move radar/EOS scan zone UP while in BVR
/ (Slash)	Move radar/EOS scan zone RIGHT while in BVR

GROUND MODE

KEY	ACTION
; (Semicolon)	Move radar/TV seeker scan zone UP
, (Comma)	Move radar/ TV seeker scan zone LEFT
. (Period)	Move radar/ TV seeker scan zone DOWN
/ (Slash)	Move radar/ TV seeker scan zone RIGHT

WINGMAN COMMANDS

KEY	ACTION
End	Dispatch wingman on mission & allow him to return to base afterwards
Del	Dispatch wingman on mission. On mission completion, join up
Home	Join up in formation
Ins	Toggle tight formation or loose formation
[	Attack my target
]	Cover my six o'clock (rear) position

VIEW SELECTION

KEY	ACTION
F1	Cockpit View
Ctrl-F1	Natural Head Movement View
Key Pad * (Asterisk)	Padlock View (Note: Must be in Cockpit View and in visual range)
F2	External View – All Aircraft
F3	Fly-By View
F4	Chase View
F5	Air Combat View
F6	Weapons View
F7	Active Ground Objects View
F8	Target View
Ctrl-F8	Target View – Target to Your Aircraft
Shift-F8	Target View – Your Aircraft to Target
F9	Ship View
Alt-F9	Landing Signal Officer (LSO) View
F10	Theater View
F11	Tower & Terrain View
Ctrl-Key Pad 5	Returns to Tower & Terrain View starting point or ends Padlock View
F12	Static Objects View

VIEW MODIFIERS

KEY	ACTION
Ctrl-Home	Places external views to Friendly only
Ctrl-End	Places external views to Enemy only
Ctrl-Delete	Places external views to All
Ctrl-Insert	Places external views to Unknown (non-aligned) only
Key Pad Delete	Toggle Padlock View (Note: for Alt-F9 LSO View & F11 Tower View only)
Ctrl-Key Pad + (plus)	Switch to Weapons Release and Track View for F2 External, F4 Chase, F7 Active Ground Targets, and F9 Ship Views only
Y	External View Information Display Toggle

COCKPIT VIEW CONTROL

KEY	ACTION
Key Pad 1	Move head down and left
Key Pad 2	Move head down
Key Pad 3	Move head down and right
Key Pad 4	Move head left
Key Pad 5	Front View
Key Pad 6	Move head right
Key Pad 7	Move head up and left
Key Pad 8	Move head up
Key Pad 9	Move head up and right
Key Pad * (Asterisk)	Toggle Padlock View (Note: Must be in Cockpit View and in visual range)
M	Move head to view right mirror
N	Move head to view left mirror

EXTERNAL VIEW CONTROL

KEY	ACTION
Key Pad 1	Move viewpoint down and left
Key Pad 2	Move viewpoint down
Key Pad 3	Move viewpoint down and right
Key Pad 4	Move viewpoint left
Key Pad 5	Centers view (Stops moving camera in F11 Tower & Terrain View)
Ctrl-Key Pad 5	Returns to starting point (F11Tower & Terrain View only)
Key Pad 6	Move viewpoint right
Key Pad 7	Move head up and left
Key Pad 8	Move viewpoint up
Key Pad 9	Move head up and right
Key Pad * (Asterisk)	Zoom in
Key Pad / (Slash)	Zoom out
Key Pad 0	Jump to head-down cockpit view and back (Note: Hold down then release)
Alt-Key Pad * (Asterisk)	Starts moving camera forward (F11Tower & Terrain View only)
Alt-Key Pad / (Slash)	Starts moving camera backward (F11Tower & Terrain View only)
Shift-(all view keys)	Moves viewpoints at a faster rate (Note: Hold down Shift and key)

MISSION EDITOR - Hold down Ctrl to select multiple objects

KEY	ACTION
FILE	
Ctrl-N	Create new mission file
Ctrl-O	Open mission file
Ctrl-A	Save mission file
Alt-X	Exit Mission Editor and return to Main Menu
EDIT	
Ctrl-Z	Undo last action
Ctrl-Y	Redo last action (cancel previous Undo)
Del	Delete selected object
VIEW	
Ctrl-H	Hide objects
Ctrl-1	Crimean view
FLIGHT	
Ctrl-B	Display Briefing
Ctrl-F	Start Mission
Ctrl-L	Network Play
Ctrl-M	Chat in Network Play
Ctrl-R	Record Track File

CAMPAIGN

KEY	ACTION
Alt-Z	Remove objects from Condition

THE MAIN MENU

The main Flanker 2.0 menu provides access to five modes of play, an options screen and a reference encyclopedia. This section describes each of these items.

Instant Combat

2-4: The Instant Combat Mode Setup Screen

The Instant Combat mode provides a quick way to fly an Su-27 or Su-33 against hostile forces. First select the type of mission, air-to-air, air-to-ground, anti-radar or anti-ship. As the names imply, the mission types determine the types of targets available during the mission. Select anti-radar, for example, to practice targeting various radar systems. Select anti-ship to practice attacking different ships.

Next, configure your aircraft. The "My Country" pull down menu specifies which country you're flying for. "My Survivability" indicates how resistant your aircraft is to damage. Configure who and what you want to fly against in the mission and then select Run.

To exit a mission, simply select the Ctrl+Q key.

My country

You may choose to fly a Su-27 for Russia, the Ukraine, Turkey, the USA or Unknown.

My survivability

- Immortal: You cannot be killed. Your aircraft takes not damage and your aircraft will "bounce" off the ground.
- Good: Your aircraft can be killed 3 times and then it will take damage normally.
- Realistic: Your aircraft will take damage normally.

Enemy

Depending upon the type of mission you select, this box will allow you to fight against all of the types of opponents available in the game.

Enemy country

You can choose to fight against Russia, the Ukraine, Turkey, the USA or Unknown. This choice does not limit what types of opponents you can select.

Enemy skill

You can select Average, Good, High, Excellent and Random.

Instant Combat Options

- Unlimited fuel and Weapons: This option gives you an unlimited amount of ordnance and fuel to fight with.

• Automatic target lock on: This option means that when the mission starts with your radar locked onto an enemy target.

• Realistic radar mode: In Instant Combat, the radar is defaulted to a simplified mode. You simply manoeuvre your aircraft in the direction of the enemy and select the TAB key (assuming you do not have the automatic target lock on option selected) to lock onto the target. To select another target, use the (~) key to cycle through the targets.

If you select the Realistic radar mode, then you can select and use the real radar. The radar starts off the mission in the simplified mode and then you can change to realistic ones as you play. For more information on realistic radar, see Chapter 4. If you do not select this option, then your radar will be locked into the simplified mode for the entire mission.

Next, configure your enemy aircraft. Select the type of aircraft you wish to fly against, which country it flies for, and the quality of the computer controlled pilot.

Training

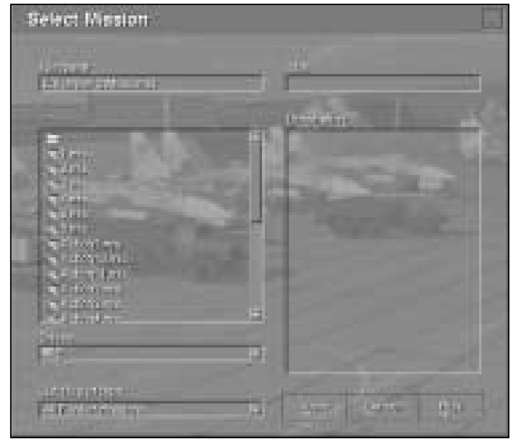
The training mode contains a series of customized, talking training missions focusing on specific pilot procedures. The missions have been pre-recorded so you may either watch the procedure performed by an experienced instructor pilot, or practice it yourself. The instructor will speak while the mission plays, describing the situation and what you should be doing. The instructor will prompt you to take control of the aircraft at your convenience by pressing the Esc Key or you can restart the mission and take control at the beginning. To exit the mission, select the Control+Q key.

2-3: The Training Mission Screen>>

The individual training missions are described in Chapter 7.

Missions

Mission Mode provides direct access to all missions installed on your computer, including those that ship with the game as well as ones you create or install later. This mode lets you view all missions, read their descriptions, and launch them without opening the mission editor.



After you select the mission button on the main screen, you will see the Mission selection screen. The missions are divided into directories, by mission type. When you select a mission, the mission briefing will appear in the Description area on the right side of the menu. As you will notice, you can search for saved and previously built missions from almost any location by using the drive (if you have multiple drives or you are connected to a network).

Once you have selected a mission, press the Run to button to go straight into the mission. Select the View key to view the mission within the Editor.

File Naming Convention

All of the playable files in Flanker have a naming convention which will automatically be created when you save that file. You can search for files by type, by using the “List files of type” box on the Select Mission menu. They file types are:

• Flanker Missions: *.mis

• Demo missions (tracks): *.trk

• Saved Missions: *.sav

• Debriefings: *.stt

Some basics about viewing your mission in the Editor:

• Your flight is shown in white. If you select it, you will see an Airgroup planning menu appear, with all of the information about your flight. This information includes:

• Aircraft mission

• Payload

• Fuel

• Route with waypoint altitudes, speeds, tasks, estimated times and targets.

• Other flights and vehicles are shown in the colour of their nation. Selecting them will bring up a menu showing their information.

• Selecting Met report from the Options (Alt+O) pull down menu in the Editor will allow you to view the mission’s weather conditions.

• Selecting Skills from the Options (Alt+O) pull down menu in the Editor will allow you to view the mission’s Skills settings

• Selecting the Edit (Alt+E) pull down menu in the Editor will allow you to see if the mission is Classified. If the Classify selection is unavailable, then the mission is classified. This means that you can look at the information in the mission, but you cannot change it.

• If you select to play a saved mission (*.sav) or a track (*.trk), you will also not be able to change anything when you view it in the Editor.

- Not all items in the mission may be viewed. In some cases the person who made the mission may have Hidden units to add an element of surprise.
- Once you are done looking at your mission, select the Start mission button (Ctrl+F) or to record the mission as a track (Ctrl+R).
- For more detailed information, see Chapter 10 on the Editor.

Campaign

Flanker 2.0 comes with a campaign consisting of a series of branching, inter-linked phases. By using the campaign tools in the mission editor to create new campaigns, the number of possible campaigns are limitless.

When you select the Campaign button on the Main Menu, the Select mission menu will be opened to the campaign directory. Campaigns have the same file names as regular missions (*.mis).

2-12: Next Phase Button

Campaigns initially play just like missions. At the end of the first phase in a campaign (select the Ctrl+Q key to end the phase), you will get an option to go onto the next phase. When you select that button, you will be taken to following phase of the campaign, if there is one and if you met the conditions to do so.

Editor

2-7: The Mission Editor

Flanker 2.0 includes a powerful mission editor, letting you create an infinite number of scenarios and campaigns that can then be traded with your fellow Flanker 2.0 pilots. Missions may be “classified” or locked to prevent others from editing them and viewing their contents before flying. By ensuring that the “surprise factor” is maintained, classified missions provide a stable base for player-run competitions.

The mission editor is fully explained in Chapter 11.

Options

2-8: The Options Screen

Flanker 2.0 is designed for a wide range of computers. You need to be away of the specifications of your computer and what options will effect the performance while you play the game. If you are playing an air to air mission, you might be less concerned with the ground textures or the greenery density, so you would turn these down to increase the game’s performance.

Also, it is very important that you optimize your computer to get the best performance. See the troubleshooting and recommended options sections at the end of this chapter and the readme for more information on this.

Graphics

The graphics section of the Options menu allows you to set your screen resolution and the major items that effect your overall game graphics.

- Resoultion: Flanker 2.0 supports three resolutions: 640x480, 800x600, and 1024x768. Higher resolutions look better, but require more CPU horsepower. Lower resolutions may not appear as sharp, but will provide smoother frame rates on slower machines. Checking the “full screen” box ensures the program runs in full screen mode instead of in a window and may help your game’s performance.
- Texture Noise: An effect that adds raised, 3D textures to a texture map. An example might be rivet on the side of an aircraft. This adds realism, but decreases performance.
- No Textures: This will turn off all of the 3D textures in the game. If the option is selected, ground, objects, map, etc. are solid. You may also disable the editor textures (found in the Miscellaneous section of the Options menu) when this is selected. This will option will greatly speed your game’s performance, but also reduce all visual effects.
- Mipmapping: Specifies the use of textures. If the option is selected, several textures are used for image of one object at various distances. If the option is unselected, only one texture is used. In this case the distortions are greater. This option decreases performance.
- Primary display adapter: This allows you to choose to play the game using your primary or (if you have on) a secondary card. Most people will have this box checked.
- 32 bit: This allows you to play the game in 32 bit colour. Be sure that your video card supports a 32 bit colour setting,

Input

The input menu lets you select what devices you have connected to your computer: joystick, thrust controller, secondary thrust controller (for dual throttle control), and/or rudder pedals.

Joystick: Select this option if you are using a joystick. If you do select this option, then the keyboard commands for your basic flight options (right, left, up, down arrows, etc.) will not function. Always insure that your joystick is calibrated and tested in Windows before you start Flanker 2.0.

Use joystick configuration:

This feature allows you to customize the configuration of your joystick within Flanker 2.0. This is a very powerful feature which not only allows you to select what your controller does, but also what it does when a certain combat mode is being used in a mission. Example: You may want button 1 on your joystick to select your next waypoint while your aircraft is flying in the navigation mode. But when you select the Close Air Combat mode, you want that button to cycle through the on-board weapons. This can all be done using the joystick configuration.

To have the setup switch between configurations within the game, ensure that the Auto Switch box is checked.

2-13: Joystick Configuration

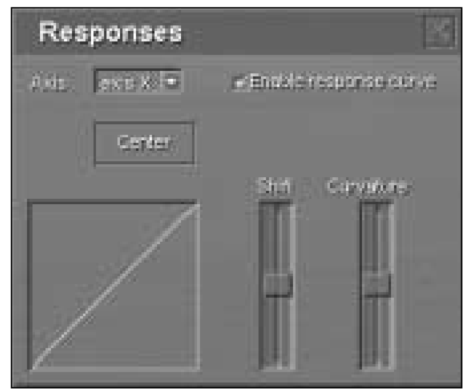
To load a pre-made setup, select the Load button on Joystick Configuration menu. You will then get a menu that lists a number of specific and generic controllers. Select the one that best fits your controller and select the Load button. Your controller will now use that setup. To view what action each button does in each configuration mode, select the configuration mode on the Joystick Configuration menu (Example: Navigation, BVR, etc.) and then select Button Mapping. This will bring up the Button Mapping menu. All of the configurations modes (Navigation, BVR, Close Air Combat, etc.) for the pre-made set-ups are the same. Customize them to fit your likes.

To have the setup switch between configurations within the game, ensure that the Auto Switch box is checked.

Caption 2-14: Button Mapping Menu

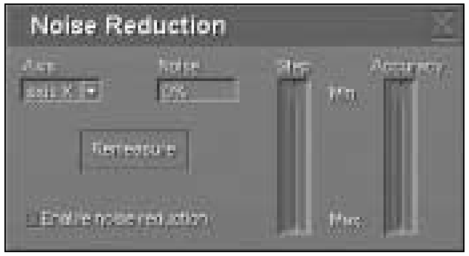
The Button Mapping menu shows all of the buttons on your controller and the functions that they have been assigned. The S, C, and A columns signify if a Shift, Control, or Alt button needs to be depressed when this button is pushed to perform this action. To remove an action, highlight the desired button in the window and then press the Remove button. To add a button action, select the button you want to add in the Button box at the top of the menu, select whether you want to have the Shift, Ctrl or Alt key depressed and then select the action in the Command box. After you have the action set the way you want it, press the Add button. Once you have the setup for that configuration the way you want it, then close the Button Mapping menu and move onto the next configuration mode that you wish to change. After you are done, press the Save button and save your new setup.

If you want to clear all actions from a configuration mode and start fresh, select the highlight the configuration mode and then press the Clear key. This will wipe out all of your button actions for that configuration mode. If you want to copy a configuration mode, select the configuration mode, press the Copy key, select the new configuration mode and then press the Paste Key.



2-15: Responses Menu

Selecting Responses brings up the Responses menu and allows you to change the shift and curvature on the X, Y, Z and R axis for your controller in each of the configuration modes. Select the Enable Response Curve box and then adjust the shift and curvature as desired. If you want to re-center it, select the Center key. This means that if you want a more responsive controller when your aircraft is in the Close Air Combat mode than in the Navigation mode, you can make that change here.



Selecting Noise Reduction brings up the Noise Reduction menu and allows you to change the Step and Accuracy on the X, Y, Z and R axis for your controller in each of the configuration modes. Select the Enable Noise Reduction box and then adjust the Step and Accuracy as desired. Move the controller to measure the noise. If you want to re-measure it, select the Re-measure key.

2-16: Noise Reduction Menu

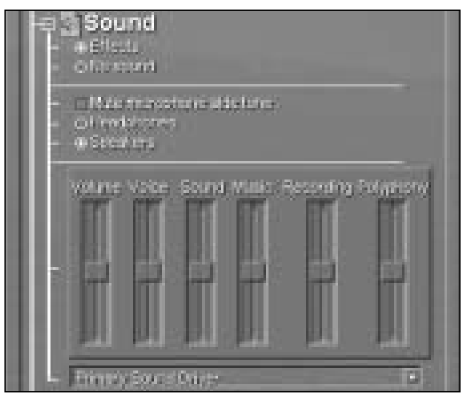
Selecting Test allows you to see the range of motion on your controller, thrust and rudder pedals. It also enables you to view the actions that buttons are set to when pressed.

Checking the Thrust, Second Thrust and Rudder Pedals allows you to use these controllers in the game.

Sound

There are a variety of sounds in Flanker 2.0 that add to the overall experience and allow you to immerse yourself more in the game. There are some important warnings and ambient sounds that occur within the game (like an incoming missile warning). You will be at a serious disadvantage if you are not able to hear them. You may also record your voice during missions (if you are using a microphone). All of these options are set here.

- Effects/No Sounds: This turns all sounds on/off in the game.
- Mute microphone: The game will not record any sound coming from your microphone if this is selected.
- Headphones/Speakers: Select the option you are using for better sound.



The Sound Levels menu found in the Options menu, allows you to adjust the various audio effects within the game.

2-17: Sound Levels Menu

- Volume: Overall volume.
- Voice: Voices (Nagging Nadia, Instructor, Wingmen, etc.).
- Sound: Sound effects.
- Music: Music (Which only occurs while a mission is not progress).
- Recording: Your recordings within the game.
- Polyphony: Multiple sounds occurring at once.

Below the Sounds Level menu, there is a box to select your sound card driver.

Terrain

The terrain options menu lets you configure the visual quality and detail of the terrain and ground objects, allowing you to customize performance for your computer and video card. You can adjust detail levels for Textures, Objects, Greenery, and Roads/Rivers along with setting visibility ranges. Higher/Farther settings will improve the graphics presentation, but reduce frame rate. Lower/Nearer settings will decrease graphics quality, but will improve frame rate.

Misc

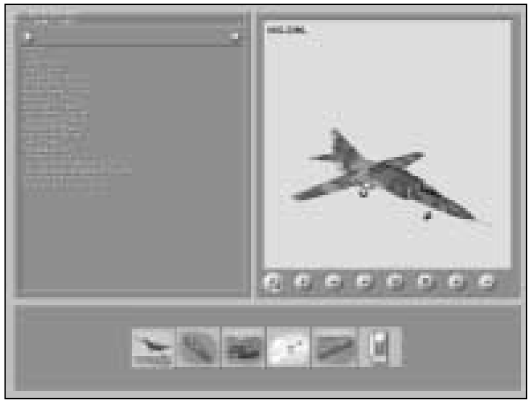
The miscellaneous options control how the program appears during play. Most of these options configure the graphics and directly impact frame rate during game play. Users with slower machines near the lower end of the recommended specifications may need to disable some of these features to improve frame rate.

- HUD in Russian: If this is not selected, the HUD will be in English.
- G-Effects: When selected, you will see blackout and redout effects.
- Cockpit Mirrors: Enables/disables the mirrors position on the canopy rails.
- Cockpit Reflection: Enables a reflection on your canopy.
- Shadows: Enables aircraft shadows.
- Non-transparent Dialog Boxes: Toggles on opaque menus and dialogue boxes.
- Disable Editor Textures: Can only be selected if the “No Textures” option has been selected. Turns off all textures in the Editor.
- Disable Buttons Animation: Enables/Disables all button animations in the game.

Network Play

Network play allows you and your friends to fly together either via local area network or over the internet, and supports both IPX and TCP/IP protocols. Details on hosting and connecting to multiplayer hosts are provided in Chapter 11.

Encyclopedia



2-9: The Encyclopedia

The encyclopedia provides an online reference for all air, land, and sea vehicles used in the simulation. Begin by clicking on the category button to select the object category you're interested in, then cycle through the available entries by selecting the drop down menu below it. The controls in the upper lright part of the menu allow you to change your view of the model.

Troubleshooting

Flanker 2.0 is a very complex game with a lot of features that can enhance your gameplay, but also drag on your performance (frame rate, graphics, etc.). In order to ensure that you have the most enjoyment possible, please take into consideration the following:

Game Play

- While there are almost always bugs in a game (even though we hate to admit it), the majority of problems that players see are not actually problems, but simply that the player did not understand how the game works. Please read the manual and the readme thoroughly.
- Patches, new missions, campaigns and information can be found at the Flanker 2.0 website: www.flanker2.com

Computer Setup

- Ensure that you have the latest drivers for all of your hardware. The number one cause of graphics problems is old video card drivers.
- Defrag your hard drive. This should be done prior to installation of Flanker 2.0. Sometimes Windows will say that you have a low fragmentation percentage and that you do not need to run the defragmentation program. Defrag your hard drive anyways and your should get better performance.
- Run Scan Disk before you install also. This will help insure a clean installation.
- Have no other programs running while playing the game. You may want to even disable some applications that begin at startup. See the readme for more details.
- Ensure that you have at least 250MB of free hard drive space on your primary hard drive for swap file space.
- Select the Options settings in the game that best fit your computer.
- In playing a 3D game, realize that the bigger the mission and the more objects that are in that mission, the slower your performance will be. If you find that your performance is still slow after optimizing your computer, then try running smaller missions.

Recommended Options Settings

Below are some recommended settings for various computer specifications. These selections seem to be a good balance between game play and performance. Your mileage may vary.

CPU	200 MHZ PENTIUM	300 MHZ PENTIUM II	400MHZ PENTIUM II	500 MHZ PENTIUM III
RAM Memory	32 MB	64 MB	128 MB	256 MB
3D accelerated video card	4MB RAM (Voodoo2 and above)	16MB RAM PCI	32MB AGP	32MB AGP
Resolution (Full Screen)	640x480	800x600	800x600	1024x768
Texture Noise	Off	Off	On	On
No Texture	On	Off	Off	Off
Mipmapping	Off	Off	On	On
Texture Resolution	Low	Medium	High	High
Objects Density	Empty	Low	Medium	High
Greenery Density	Low	Medium	Medium	High
Roads, Rivers	Empty	Low	High	High
Details Visibility	Near	Medium	Far	Far
Chimney Smoke	Off	Off	On	On
G-Effects	Off	On	On	On
Cockpit Mirrors	Off	Off	On	On
Cockpit Reflection	Off	On	Off	On
Shadows	Off	Off	On	On
Non-transparent dialog boxes	On	Off	Off	Off
Disable Editor Textures	On	Off	Off	Off
Disable Buttons Animation	On	Off	Off	Off

CHAPTER 3
Cockpit

Defense Visual Information Center - Department of Defense

The cockpit of the Su-27 can be divided into two main sections: the Instrument Panel and the Head Up Display (HUD). The panel contains most of the flight instruments. The HUD displays the main navigational and combat information; its detailed description is given below in a separate section. A number of indicators, buttons and levers, including the Throttle, are located on the side panels of the cockpit, but this manual does not describe them because of their unimportance to this package.

INSTRUMENT PANEL

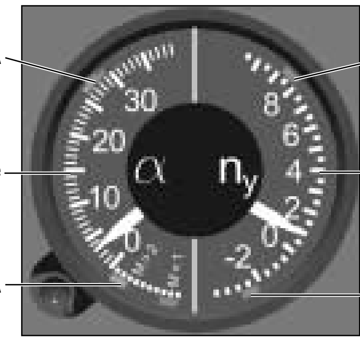
Use the Numeric Keypad to move your head around. A front view of the Instrument Panel (pilot's head is lowered down) is shown in the figure below. The layout of the instruments, controls and their operation almost completely correspond to those of the real Flanker.

The Instrument Panel

Flight Instrumentation

Combined G Meter & AOA Indicator

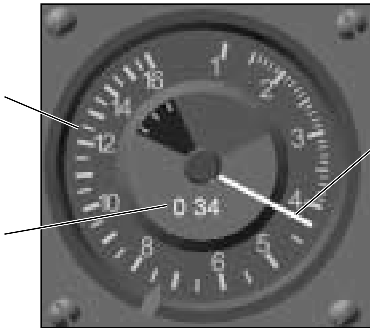
This instrument is located in the upper left corner of the Instrument Panel. The scale of the AOA Indicator (left side of the instrument) has uniform marks in the range from -20° to 40°. The red mark on the scale marks the maximum operational angle of attack. On the right side of the instrument is the G-Load scale uniformly marked every 2 Gs from -4 to +10g.



Airspeed Indicator & Mach Meter (ASI)

The ASI is situated to the right of the G Meter and displays the current indicated airspeed (IAS) and Mach number. While true airspeed (TAS) measures the aircraft's speed against a fixed point, IAS, on the other hand, takes into account the change in air pressure at altitude and how it affects flight. At sea level, TAS and IAS are identical. At high altitude, IAS is much lower than TAS because of the thinner atmosphere. A Flanker flying at 350km/hr IAS will have similar flight characteristics at any altitude. IAS, in other words, accounts for the decreased pressure at higher altitude and the subsequent decreased lifting capability of the wing. As a result, IAS provides a near constant measure for stall speed, regardless of altitude.

The scale of the ASI is marked from 0 to 1600 km/h and is non-linear (the values of the scale divisions grow with increase in speed). The three-digit Mach number indicator reflects the ratio of true airspeed to the speed of sound under the given flight conditions.

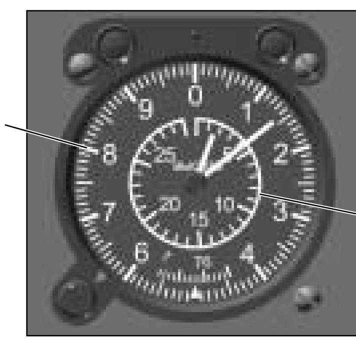


Radar Altimeter

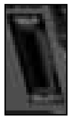
The Radar Altimeter is right below the Combined G Meter & AOA Indicator. It indicates the aircraft's altitude in meters above the terrain. The scale of the instrument is marked from 0 to 1000 meters and is non-linear with larger spacing at lower altitude for increased precision.

Barometric Altimeter

Located below the ASI, the barometric altimeter measures the aircraft's altitude above sea level. The small needle uses the internal ring, ranging from 0 to 30km. The larger needle uses the external ring and measures from 0 to 1,000m. Adding the two scales together shows the aircraft's altitude above sea level.

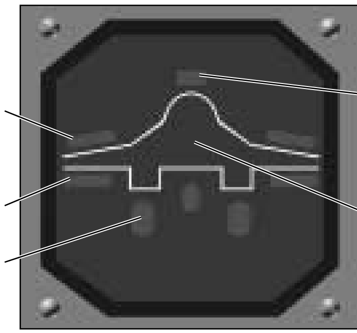


Slats Indicator



The Slats (or leading edge flaps) Indicator is to the left of the Radio Altimeter. The white portion of the bar indicates the position of the slats. The lower the white needle, the farther the slats are released. Note that the slats on the Flanker are controlled automatically by the flight control system and configure to the optimum angle for the aircraft's attitude, angle of attack, speed, weight, and altitude.

Configuration Display



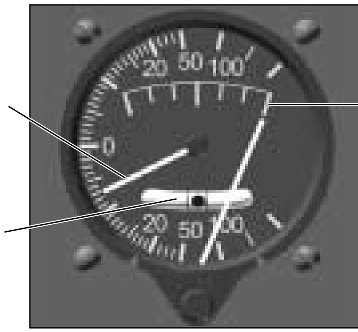
In the lower left-hand corner of the Instrument Panel below the Radar Altimeter is the Configuration Display. It shows information about the positions of the landing gear, flaps, anti-FOD screens, air brake and drogue chute (and the tailhook in the case of the Su-33). Illumination of any indicator by a green light means that the corresponding control is in the active position, i.e. deployed. A flashing green light means that the control is in movement. The anti-FOD screens are automatically actuated on take-off and landing.

Clock

The clock shows the current time within the simulation.

Variometer

The Variometer is situated between the Attitude Direction Indicator and the RPM Indicator and shows your current rate of climb and turn. The scale of the instrument is non-linear ranging from 200 m/s (climb) to -200 m/s (dive). Thus, in the area of zero vertical speed the scale has the highest accuracy. The rate of turn scale ranges from 3°/sec left to 3°/sec right with a 1-degree interval.



The small ball on the sideslip scale slides in the direction of the aircraft's sideslip. This indicator is used to coordinate the input of rudder to help to coordinate turns. The pilot "steps on the ball" (applies rudder on the same side as the ball) to center it in the indicator...

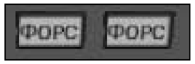
Neutral Trim Indicator

This indicator is located right below the Horizontal Situation Indicator. The highlighting of the Neutral Trim Indicator means that the trimmer is in the neutral position. As soon as you start to trim using the joystick coolie hat or the trim control keys, the light is disabled.

RPM Indicator

The RPM Indicator is located to the left of the MFD. The scale of the indicator is graduated from 0 to 110% in tens of percent. Two separate needles measure port and starboard engine thrust. When both engines are operating at the same thrust, it will appear that only one needle is visible.

Afterburner Engaged Indicators



The Afterburner Engaged Indicators are right above the RPM indicator. They are highlighted when the afterburner lights and engine RPM exceeds 100%. The word **ФОРС** on the indicators (pronounced "fors") which is short for "forsazh) denotes "afterburner" in Russian.

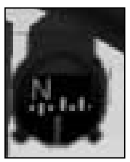
Autopilot Engaged Indicator

Illumination of this indicator located to the right of the Configuration Display designates operation of the Automatic Control System in autopilot mode. The Russian **АВТО** (pronounced 'af-to') denotes autopilot, and is toggled by the **A** key.

Altitude Stabilization Indicator

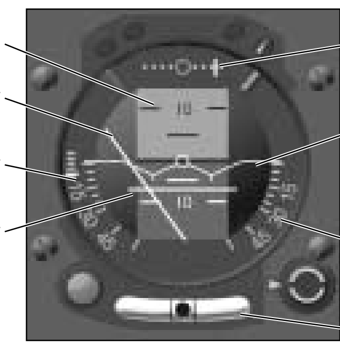
The Altitude Stabilization Indicator is to the right of the Autopilot Engaged Indicator below the Barometric Altimeter.The Russian **H-СТАБ** (pronounced 'ash-stab'.) denotes that the Automatic Control System is in altitude stabilization mode. Toggle the altitude stabilization mode with the **H** key.

Magnetic Compass



The forward frame of the cockpit canopy houses three rearview mirrors and the Magnetic Compass. The compass consists of a ball with a scale, which is enclosed in a casing and plunged in a liquid. The scale on the ball is marked in 30° increments and has designations of the cardinal points (North, West, South and East).

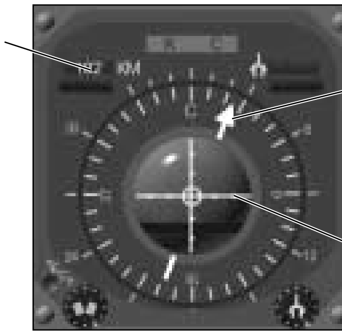
Attitude Direction Indicator (ADI)



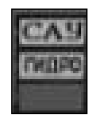
In the center of the Instrument Panel just below the Weapon Readiness Indicator is the Attitude Direction Indicator (ADI) or artificial horizon. It is the main navigational instrument, especially in zero visibility conditions.

The mobile Pitch Scale and the Aircraft Datum (symbolic image of the aircraft in the center) show the aircraft's spatial orientation with respect to the horizon. The ADI also receives control information on the pitch angle, bank, heading, and altitude required to reach the next navigation waypoint. This information is supplied by the navigation system, and it enables the pilot to manually fly the Flanker and follow a specific flight plan.

Horizontal Situation Indicator (HSI)



Automatic Control System Failure Indicator



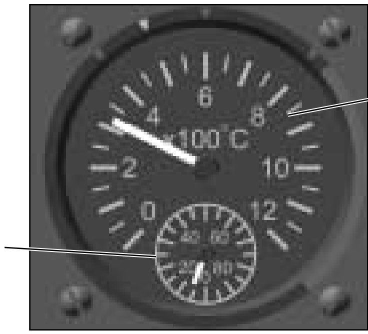
The illumination of the ACS Failure Indicator **САУ** (pronounced "sau," stands for Automatic Control System) located to the right of the HSI signifies a failure of the Automatic Control System. This indicates a disturbance and/or failure in the operation of Autopilot and Altitude Stabilization systems.

Hydraulic System Failure Indicator

The Hydraulic System Failure Indicator **ГИДРО** (pronounced "gid-ro," stands for HYDRO) is just below the ACS Failure Indicator. This kind of failure results in the loss of control of the flaps, slats, and the air brake, plus diminished authority of elevator, rudder and flaperons.

Jet Pipe Temperature Indicators

The two indicators located to the right of the HSI show jet pipe temperature of gases at the turbine exhaust of both AL-31F engines. Each indicator consists of two circular scales, the large scale ranging from 0 up to 1000° Celsius and showing the temperature in hundreds of degrees. The small scale renders more precise the reading taken from the large scale and has a range of 100°C in tens of degrees. Exact temperature is read by combining the two scales.

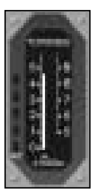


Maximum Engine Temperature Indicators

Located just below the Jet Pipe Temperature Indicators are the Max Engine Temperature Indicators. Critical jet pipe temperatures are symptoms of impending engine failure, engine compressor failure, missile strike, etc.

A failure of the power plant often leads to a spontaneous increase of gas temperature at the turbine exit and a drop in RPM. This situation is immediately reflected on the RPM Indicator and the Jet Pipe Temperature Indicators.. An engine on fire or suffering catastrophic failure will shut down automatically and a powerful halogen extinguisher will be released into the engine area.

Fuel Gauge

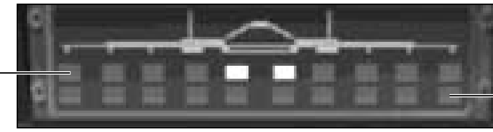


The Fuel Gauge is to the right of the Jet Pipe Temperature Indicators. It indicates total fuel remaining in the tanks. The vertical scale of the instrument is marked in tons and uses two scales to measure from 0 to 9 tons. The scale on the left marks 0 to 5 tons; the scale on the right marks 5 to 9 tons.

At the top of the Fuel Gauge is the **ТОРЛИО** light (denotes "fuel" in Russian, should be pronounced "top-li-vo"). When this is highlighted, you are on your reserve fuel, and its definitely time to return to base as things could be going awfully quiet soon. But don't panic too much as the reserve guarantees successful flight to the nearest diversion airfield in case a landing is impossible on the initial airfield (runway destroyed, poor visibility, etc.).

Combat Instrumentation

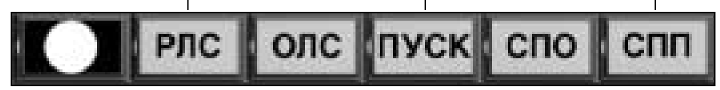
Weapons Readiness Panel.



This indicator is located just below the HUD and shows the location and readiness of the available weapons hanging on 10 underwing and fuselage pylons. The illuminated lights in the upper row indicate the presence of weapons on the pylons, and those in the lower row the readiness of the corresponding weapons to instant use. Note that such readiness is governed not only by the selection of the weapon, but also by the specific combat situation.

Master Warning Panel Failure Lights

Located just below the Weapons Readiness Panel, the Warning Panel provides visual and audible alerts to system failures and launch warnings. It consists of five indicators:

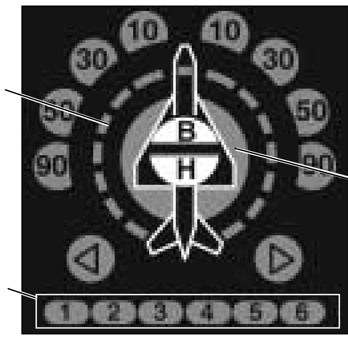


- **Master Warning Light:** The flashing red Master Warning Light accompanied by beeps attracts your attention to vital information such as ground proximity, stall, damage to any systems of the aircraft, low fuel, illumination of your aircraft by radar and others. The Master Warning Light is the main form of notification when the following system damage failures, or other events occur: gear up of down, launch authorization, Gmax or AOA max, out of fuel, or minimum or maximum speed reached.
- **РЛС**("rls") Radar Failure
- **ОЛС**("ols") Electro-Optical System Failure
- **ПУСК**("pusk") Missile Launch Warning
- **СПО**("spo") Radar Warning System Failure
- **СПП**("spp") Missile Launch Warning System Failure

Chaff/Flare Counter

Below the MFD is the Chaff/Flare Counter, which shows how many APP-50 combined chaff and flare dispensers remain at your disposal. The initial value of the counter is 32 for the Su-27 and 51 for the Su-33. The counter reads zero if the chaff/flare deployment system is damaged or you've run out of dispensers. Pressing the **ALT-Q** toggles the continuous dispenser on or off. When activated, the dispenser will deploy chaff and flares until either the player turns the dispenser off or the supply of chaff and flares is exhausted.

Threat Warning Display



In the lower right-hand corner of the cockpit is the Threat Warning Display (TWD). It depicts information on enemy illumination sources detected by the SPO-15 'Beryoza' Radar Warning System. Such sources can be enemy aircraft, radar of SAM installations, AWACS, and so on. Lights surrounding the aircraft's silhouette show the approximate bearing of the illumination source: if the aircraft falls within radar coverage, the corresponding light flashes at a frequency characterizing the periodicity of illumination, and the audio alarm beeps. In the event of a "lock on" the red Lock-On Indicator is continuously illuminated.

In the lower part of the TWD are 5 lights indicating the type of radar that has locked onto your aircraft. The Radar Warning System provides for the identification of the following types of radar:

1 - airborne radar

2 - radar of a long-range SAM system

3 - radar of a mid-range SAM system

4 - radar of a short-range SAM system

5 - early warning radar (airborne or ground-based).

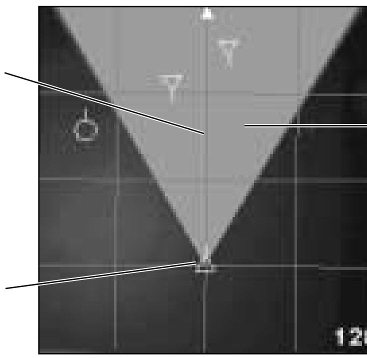
Active Jamming Indicator

Below the Chaff/Flare Counter is the Active Jamming Indicator **АП** ("ap"). This indicator shows activity of the built-in and/or additional Sorbtsiya active jamming system. If the indicator is not highlighted, your active jamming system is damaged or turned off. The active jamming system is toggled by the **E** key.

MULTI-FUNCTION DISPLAY (MFD)

The Multi-Function Display (MFD) dominates the right-hand side of the instrument panel. The MFD is the most versatile of all instrumentation in the Flanker, displaying different types of data depending on the selected avionics mode. The MFD generally displays a "top down" view, with the symbology and objects displayed varying depending on the selected avionics mode.

Each avionics mode is described, complete with illustrations of the MFD symbology, in the Avionics chapter.

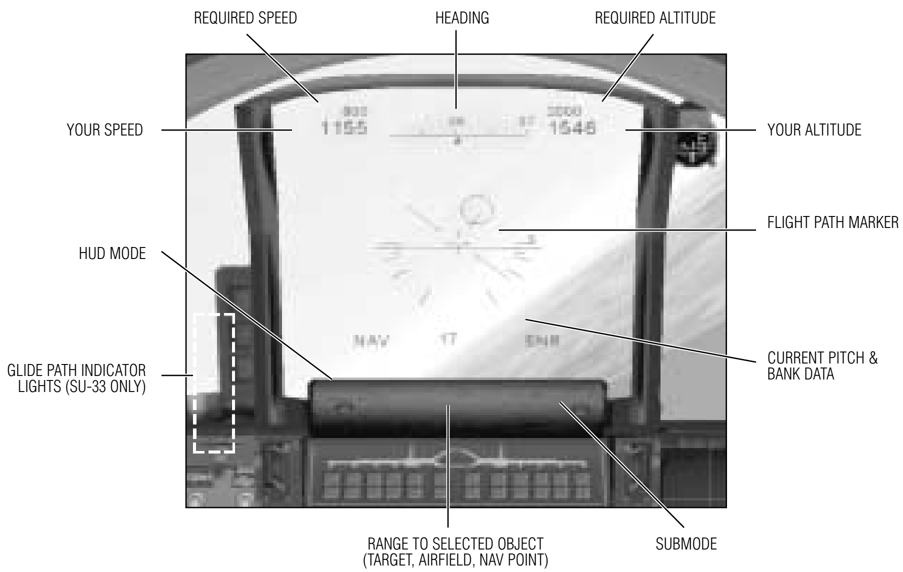


HEAD UP DISPLAY (HUD)

The most important multi-function instrument of the Flanker is the Heads-Up Display (HUD). The HUD displays a wide variety of flight attitude, navigation, weapons, and targeting information depending upon the selected avionics mode. Generally speaking, the HUD always displays your airspeed (in km/hr), your altitude (in meters), your heading, and your flight attitude (pitch and bank). The altitude display will vary between MSL (altitude above mean sea level) and radar AGL (altitude above ground level). When displaying AGL, the symbol **P** (the Russian letter "R" for "Radar Altimeter) appears next to the altitude display. Radar altimeter data is valid only when banking less than 45 degrees or pitching less than 70 degrees. The HUD also displays the currently selected avionics mode in the lower left corner. By default, the mode name is displayed in Russian; you can configure this to English via the Options menu. The possible modes are:

RUSSIAN DESIGNATIONS	ENGLISH DESIGNATIONS	PURPOSE
НАВ (NAV)	NAV (Navigation)	Basic navigation mode, heading + stopwatch.
SUBMODES:	SUBMODES:	
МАРН (MARSH)	ENR (En-route)	Follow flight path.
ВОЗВ (VOSV)	RTN (Return)	Return to selected airfield.
ПОС (POS)	LNDG (Landing)	Land on selected airfield. ILS approach.
НАВ (DVB)	BVR (Beyond Visual Range)	Engage airborne targets at long ranges.
SUBMODES:	SUBMODES:	
ОБЗ (SKAN)	SCAN (Scan)	Scans a mximum of 24 contacts.
СНП (SNP)	TWS (Track While Scan)	Tracks 8 contacts while scanning up to 16 contacts.
(DRLO)	AWACS	Displays contacts from AWACS datalink.
АТК (ATK)	ATK (Attack)	One target locked-up.
БВБ (BVB)	CAC (Close Air Combat)	Dogfight at close range.
СТР (STR)	BORE (Radar Bore Site)	Aim using forward looking bore site of radar beam.
ФИО (FIO)	LNGT (Longitudinal missile aiming)	Aim using the selected missile guidance system at visual ranges.
ШЛЕМ (SHLEM)	HMTD (Helmet-Mounted Target Designator)	Engage agile targets using helmet-mounted target designator.
ЗЕМЛЯ (ZEMLYA)	GND (Ground Attack)	Destroy ground targets.
ПР (PR)	LA (Shoot)	Authorized to fire weapon.
ОТВ (OTV)	NO LA (Don't Shoot)	Not Authorized to fire weapon.

Each avionics mode is described, complete with illustrations of the HUD symbology, in the Avionics chapter.



CHAPTER 4

Avionics and Combat Systems

Defense Visual Information Center - Department of Defense

INTRODUCTION TO AVIONICS & COMBAT SYSTEMS

Flanker 2.0 offers a complex and realistic portrayal of the real-world avionics suite found in the Su-27 and Su-33. By Western standards, these systems are generally regarded as inadequate, creating high pilot workload. To get the most out of the Flanker, you must learn how to operate its systems and how to cope with its design limitations.

All HUD displays fall into one of three categories: navigation, air-to-air combat, or air-to-ground combat. Sub-modes organize and display different types of information. Generally speaking, it's not necessary to utilize every sub-mode for each category; however, each sub-mode is designed for a particular task.

Russian vs English Displays

To create the most authentic simulation of a Russian aircraft, all displays and HUD indicators default to the Russian language with Cyrillic characters. You may, however, switch the displays between English and Russian language in the Options menu under "miscellaneous." Please note: regardless of the language used, all displays will still use metric units. Altitude is measured in meters and airspeed is measured in Kilometers per hour.

NAVIGATION

The navigation modes are your primary means of finding your way around the simulated battle-field. There are four navigation submodes.

RUSSIAN DESIGNATION	PRONOUNCED	ENGLISH DESIGNATION	MODE TYPE	PURPOSE
НАВ	“nav”	NAV	Piloting	Visual navigation with a compass and stopwatch
МАРШ	“marsh”	ENR	Enroute	Enroute navigation
ВОЗВ	“vosv”	RTN	Return	Return to the Initial Approach Fix at the home airbase.
ПОС	“pos”	LNDG	Landing	Activates the Instrument Landing System (ILS) and autoland feature (for carrier operations.)

To select the navigation category press the 1 key. This selects the default navigation mode, Piloting. Cycle through the various individual navigational submodes by hitting the 1 key repeatedly.

НАВ–(NAV) – Piloting Mode

The piloting mode is the initial navigation mode, automatically displayed whenever you first press the 1 key while in another mode. This mode provides only minimal information. The HUD shows airspeed, altitude, and flight attitude information while the MFD shows airfields and the Admiral Kuznetzov aircraft carrier, if present. Use this mode for free-form flying without any pre-determined plan.

*4-1: The **НАВ** (NAV) - Piloting Hud*

МАРШ (ENR) - Enroute Submode

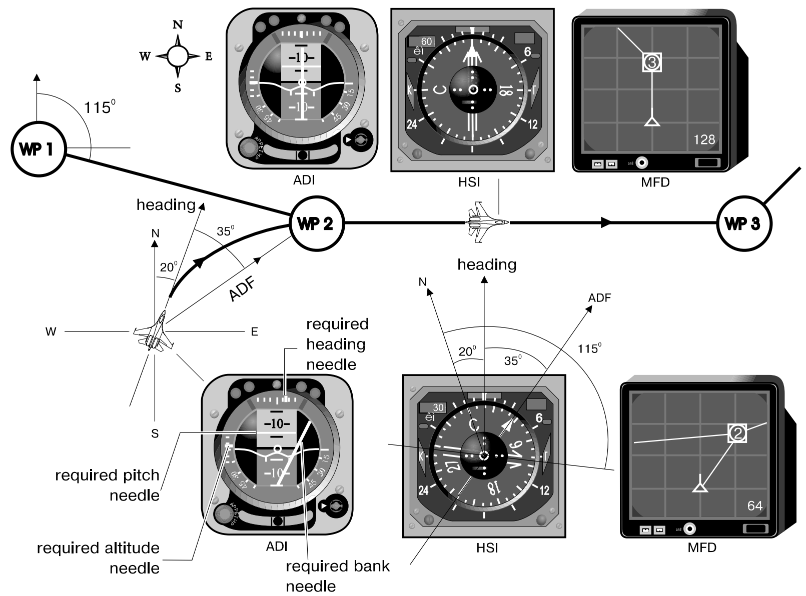
The МАРШ (ENR) submode is the primary navigation submode, enabling the pilot to fly the pre-determined mission flight profile. Select it by pressing the 1 key while in the initial NAV or Piloting mode. Each waypoint is characterized by its coordinates on the ground, its altitude, and the desired airspeed for that leg of the trip. This mode displays the required speed and altitude of the waypoint in small characters located above the actual speed and altitude readouts of the aircraft. A circle or navigation reticle, inside the HUD points the way to the next waypoint. Manoeuvre the aircraft to center the navigation reticle in the HUD and you’re heading directly to the next waypoint. Numbers in the center of the HUD’s bottom edge indicate the distance to the next waypoint in kilometers.

*4-2: The **МАРШ** (ENR) Submode*

Backup Instruments

The instrument panel also provides navigation information. The MFD symbolizes your position, the waypoint , and the desired flight path to the next selected waypoint. The ADI yellow predictor bars (“needles”) mark the desired bank and pitch angles while the HSI shows the required heading and distance to the next waypoint. In general, if the HUD becomes unservicable, you can still nav-igate using the instrument panel.

The МАРШ (ENR) submode provides no combat information. Generally speaking, select this mode, set your course, and then select a more appropriate combat mode. Occasionally return to МАРШ (ENR) mode to verify your flight path. Press the ~ key to cycle through waypoints.



4-3: Reading the МАРШ (ENR) Submode instrumentation

In figure 4.3 the aircraft on approach to waypoint 2 is misaligned by about 35 degrees to the left. This is reflected on the HSI (see the instruments at the bottom of the figure): the current heading is 20 and the ADF arrow (the narrow needle) reads 55 degrees. The distance to waypoint 2 is 30km (upper left corner of the HSI). The desired radial, the desired flight path from waypoint 1 to waypoint 2, is shown by the flight path marker (the wide needle). In other words, the ADF needle points directly to the next waypoint while the flight path marker points to the pre-programmed flight path to that same waypoint.

The ADI also shows the misalignment between the aircraft's heading and the next waypoint. The required bank needle points to the right, indicating the aircraft needs to turn to the right to reach the next waypoint. If the aircraft were on course, the needle would point straight up. The required altitude needle on the left of the ADI shows that the aircraft is quite close to the desired altitude.

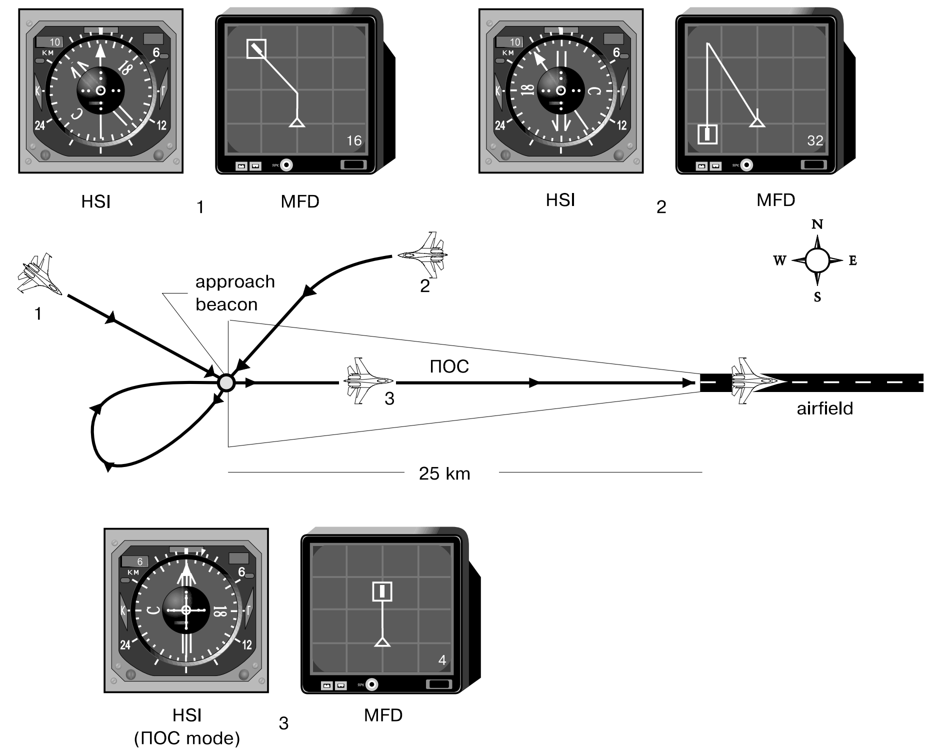
If the aircraft is on the planned flight path, as is the aircraft between waypoints 2 and 3 in the same figure, then the wide and narrow arrows on the HSI are aligned and pointing straight up. Likewise, the required bank needle on the ADI is also pointing straight up.

ВОЗВ (RTN) – Return Submode

The ВОЗВ (RTN) submode directs you to the Initial Approach Fix (IAF) for the runway you are landing at. Think of the IAF as the last waypoint before reaching the airbase, where you will intercept the Instrument Landing System (ILS) and begin your approach. For all intents and purposes, ВОЗВ (RTN) is identical to МАРШ (ENR) except that ВОЗВ (RTN) only has one waypoint: the IAF for the runway.

4-4: The ВОЗВ (RTN) - Return Submode

You select the ВОЗВ (RTN) submode by pressing the 1-key twice from the initial NAV mode. You may cycle through the available runways and their IAFs by pressing the ~ key.



4-5: Reading the ВОЗВ (RTN) - Return Submode Instrumentation

When flying towards the IAF, the wide arrow on the HSI always indicates he bearing from the beacon to the selected airfield and normally is the same as the runway heading. Figure 4-5 illustrates the readings of the HSI and the MFD for three aircraft with different positions relative to the approach beacon. Aircraft 1 is 10km from the beacon and flying a heading of 135, on track to the IAF. Aircraft 2 is 10km from the IAF, flying a heading of 270. The misalignment between the current heading and the required heading is 35 degrees. In other words, the pilot must turn 35 degrees to the left to fly directly to the IAF. Aircraft 3 is flying the runway heading, between the runway and the IAF. In this case, the MFD shows only a straight line from the runway to aircraft marker.

When the aircraft reaches the IAF, the navigation software automatically switches to the ПОС (LNDG), or landing, submode.

ПОС (LNDG) Landing Submode

You can, however, switch directly to Landing submode by pressing the 1 key repeatedly until the ПОС (LNDG) indicator is displayed on the HUD. If the airfield is equipped with an ILS, the Glideslope and Localizer bars are displayed. A vertical velocity scale will appears on the right side of the HUD. The ideal touchdown should occur at a sink rate of 1 to 1.5 m/s.

4-6: The ПОС–(LNDG) Landing Submode with ILS

For more information on landings, see the section on landings in Chapter 5, Ground School and the appropriate training missions in Chapter 7, Training.

RADAR AND ELECTRO-OPTICAL SYSTEM

The weapons control system (WCS) of the Su-27 and the Su-33 integrates the weapon and target data and parameters from the following components:

- The Zhuk-27 or Miech-33 airborne radar;
- The 36-Sh Electro-Optical System (EOS);
- The onboard weapons management software;
- Individual weapon targeting hardware and software;
- The data presentation system (MFD and the HUD);
- The Parol (Password) Identification Friend or Foe (IFF) interrogator which processes signals from air and ground installations equipped with pertinent transponders;
- The Helmet-Mounted Target Designator (HMTD);
- Target data feed from AWACS.

Zhuk-27 radar (Su-27)

The Phazotron Zhuk-27 (Beetle) coherent pulse-Doppler jam-proof radar is fitted with a twist cassegrain antenna of 700 mm in diameter and has the following features:

Air-to-air mode

- Look/down-shoot/down capability;
- Range-while-search of up to 24 contacts;
- Track-while-scan of up to 8 contacts;

Miech-33 radar (Su-33)

The Phazotron Miech-33 (Shield) is also a coherent pulse-Doppler jam-proof radar with the same air-to-air characteristics as the Zhuk-27, but additionally offers a powerful air-to-surface mode.

Air-to-air mode

- Look/down-shoot/down capability;
- Range-while-search of up to 24 contacts;
- Track-while-scan of up to 8 contacts;

Air-to-surface mode

- Real beam ground mapping;
- Doppler beam sharpening;
- Synthetic aperture;
- Map enlargement/freezing capability;
- Detection and tracking of moving ground or seaborne targets;
- Air to surface ranging.

Radar Cross Section (RCS) of the target, or the size of the reflecting surface of the target, has a substantial impact on radar detection performance. In general, large targets reflect more radar energy, so a B-52 can be detected farther away than an F-16. For a target with an effective RCS of 3 m2 (a typical sized fighter) the Zhuk-27 has a maximum detection range of 150 km (93 miles) when facing the target's forward hemisphere and 55 km (34 miles) when facing the target's rear hemisphere.

The radar transmits radio pulses of nearly equal frequency (within the X-band) and phase (coherent radiation). The radar measures the range to the target by timing how long it takes for the reflected waves to return to the transmitter. The greater the range, the longer it takes the waves to return. When the pulses are reflected from a moving target, the frequency shifts due to the Doppler effect. Pointing the radar at the ground, naturally, results in lots of radar reflections appearing on the scope. These returns are called ground clutter. Most modern radar systems take advantage of the Doppler effect and filter out any returns that are stationary, thus filtering out the extra returns from ground clutter. This does have one side effect, however, an airborne target that has no movement relative to the transmitter appears stationary and is filtered out. This condition typically occurs when the target moves perpendicular to the transmitter, and therefore appears stationary (in terms of how fast the transmitter is closing on the target). This effect is called "beaming" and is an effective defense against airborne radars.

You toggle the radar by pressing the **I** key. The Radar Cue **И** (Russian "I", stands for 'illumination') on the left of the HUD indicates that the radar is active. If the Radar Cue does not appear when you enable the radar, this means that latter is damaged.

36-Sh Electro-Optical System

See EOS The radar is backed up by the 36-Sh electro-optical system (EOS) designed by the NPO Geophysica. The EOS can acquire thermally contrasting targets with high accuracy. It combines a laser rangefinder (effective tail-on range of 8 km/5 miles) and Infra-Red Search and Track (IRST) system (maximum effective range of 50 km/31 miles). These use the same optics, which consist of a periscopic system of mirrors and an articulated glass sensor ball mounted centrally in front of the windscreen. The sensor ball moves in elevation (-15° down and +60° up) and in azimuth (60° left and 60° right of center, respectively). The information update rate depends on the field of view size and varies from 2 (search in wide area) to 0.05 (autotrack mode) seconds.

The EOS operates passively (emits no detectable signal) by receiving infra red emissions from the target. This allows the pilot to prepare a surprise attack on the enemy. Maximum detection ranges depend on the attack geometry. It changes from 15 km for forward-hemisphere attacks to 50 km for attacks in the rear hemisphere. The range to a target can be accurately measured only at relatively close distances (from 200m to 3 km). In order to measure distances outside laser range when a target is locked (TAB Key) the radar sends short strobe bursts or pules towards the contact. Once the contact comes within 9 Kilometers, the strobe pulse ceases and the laser rangefinder takes over. These pulses are extremely short and difficult to detect with accuracy, thus providing little opportunity to locate the source. You mainly use the EOS to provide targeting data for air-to-air missiles with an IR seeker head and for tracking targets in a guns fight.

To toggle the EOS, press the O key. The EOS Cue **T** (stands for 'Thermal') on the left side of the HUD indicates that the EOS is active If the EOS Cue does not appear at all, this indicates that the EOS is either damaged or not correctly selected.

The EOS, radar, or a missile's seeker can be slaved to the pilot's helmet-mounted target designator (HMTD) allowing the pilot to target simply by moving his head in the direction of the enemy aircraft. This is extremely convenient for acquiring agile targets at visual ranges.

Since the principles of using the radar and the EOS are practically the same, we describe these principles for the various combat modes in the same place, pointing out distinctions as needed.

Scan Cone Basics

To understand how the radar/EOS searches for targets, imagine walking through a forest with a flashlight on a pitch-black, moonless night. You can only see objects illuminated by the flashlight beam, and the beam grows weaker as it extends from the light bulb. This essentially describes the problems using radar to search for targets. In simple terms, the radar extends something like a cone in front of the transmitter. The farther it goes, the bigger the cone gets. Objects outside of the cone will pass undetected. As a result, it is necessary to turn the aircraft occasionally and to "slew" the scan cone using the Shift - ; (up)Shift - . (down) Shift - ' (left)Shift - / (right) keys, much like moving the flashlight around the darkened forest.

Objects inside the cone will reflect radar energy back toward the transmitter. But, radar waves lose power as they travel. If they travel far enough, they eventually dissipate. Consequently, contacts at long range may not reflect enough radar energy; the reflected waves dissipate before making it back to the transmitter. Therefore, if the radar energy can travel 150km, bounce off a target, and return 150km to the source, then the radar energy is also capable of travelling at least 300km in a straight line. This means that the enemy can detect your radar transmissions from well outside of your effective search range!

The EOS works similarly, except that it is a passive system; instead of looking for reflected radar waves, it looks for heat emitted by targets. As a general rule, hotter targets (fighters using afterburner) can be detected further away. Also, rear-aspect targets (with the heat source pointed at the EOS) will generally be detected further away than nose-aspect targets (since the enemy aircraft is blocking the view of the engine exhaust).

AIR-TO-AIR COMBAT

During an attack on an airborne target the pilot usually goes through the following steps: search, locate, track, identify, and attack. He can accomplish these steps both with and without the radar and/or the Electro-Optical System (EOS) . The selection of one or other type of weapon mainly depends on the range to the target and the possibility of tracking the target using the onboard radar or EOS.

The following table describes the main air-to-air HUD:

The table below is a summary of the keys you will often use in air to air combat.

KEY	ACTION
I	Toggle radar.
O	Toggle EOS.
`	Select next AWACS contact on Multi-Functional Display (MFD)
Tab	Place designated contact in Track While Scan from Scan
Ctrl-Tab	Remove tracked contact from Track While Scan
Tab	Lock tracked target to Attack Mode
Tab	Lock/unlock target to Attack Mode in CAC submodes
; (Semicolon)	Move HUD target designator UP
, (Comma)	Move HUD target designator LEFT
. (Period)	Move HUD target designator DOWN
/(Slash)	Move HUD target designator RIGHT
Shift - ; (Semicolon)	Move radar/EOS scan zone UP in BVR modes
Shift -, (Comma)	Move radar/EOS scan zone LEFT in BVR modes
Shift -. (Period)	Move radar/EOS scan zone DOWN in BVR modes
Shift - /(Slash)	Move radar/EOS scan zone RIGHT in BVR modes
Ctrl+I	Center radar antenna/ IRST ball
-(Minus)	MFD/HUD Zoom in
+(Plus)	MFD/HUD Zoom out
D	Cycle through weapons
C	Enable/disable cannon
Ctrl+V	Toggle Salvo mode
Ctrl+W	Jettison weapons/Load Weapons, step-by-step

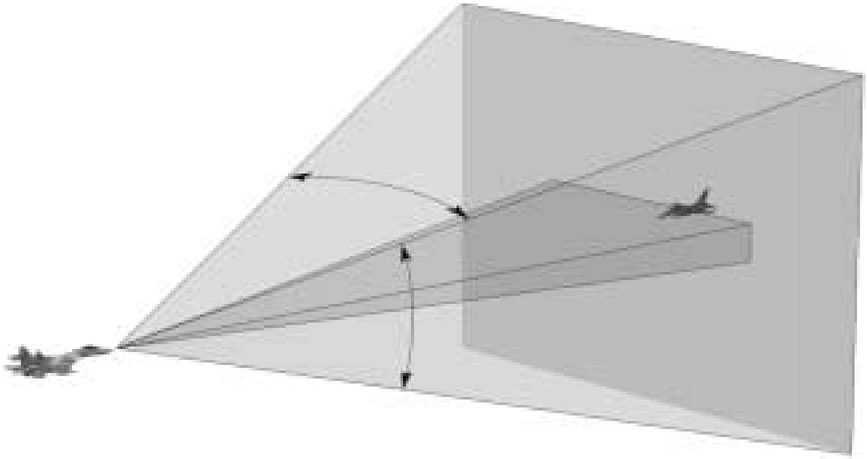
Air-to-Air Mode Summary

The following table lists the different avionics modes available for air-to-air combat. Note that they fall into three categories: beyond visual range, close air combat, and longitudinal missile aiming.

FLIGHT / COMBAT MODE	RUSSIAN	ENGLISH	KEY	PURPOSE
Beyond Visual Range - Scan	ДВБ-ОБЗ	BVR – SCAN	2	Acquire up to 24 tar gets at 25 km to 150 km ranges.
Beyond Visual Range -Track While Scan	ДВБ-СНП	BVR - TWS	2	Tracking up to 8 contacts while scanning up to 16 more.
Beyond Visual Range - AWACS Datalink	ДВБ-ДРЛО	AWACS	2	Using AWACS information for attacking targets when radar and EOS is off. (Requires AWACS)
Close Air Combat – Vertical Scan	БББ-ВС	CAC – VS	3	Dogfight at ranges from visual to 25 km
Close Air Combat – Radar Bore Site	БВБ-СТР	CAC – BORE	4	Aim using forward looking bore site of radar beam.
Close Air Combat – Helmet	БВБ-ШЛЕМ	CAC – HMTD	5	Aim using helmet-mounted target designator.
Longitudional Aiming	ФИО	LNGT	6	Aiming using a missile's seeker at ranges from visual up to max IR/active range of missile
Attack	ДВБ-АТК БВБ-АТК ФИО-АТК	BVR-ATK CAC – ATK FIO – ATK	Tab	Auto-tracking one target (Target Locked).

ДВБ (BVR) Beyond Visual Range Mode

In ДВБ (BVR) Beyond Visual Range Mode, both the radar and the EOS scan in a limited area - the scan cone has angular dimensions of 10° in the vertical plane (elevation scan angle) and 60° in the horizontal plane (azimuth scan angle). You can move the radar/EOS scan zone within the gimbal limits of the antenna/seeker. The scan zone dimensions of the radar are 120° x 120° , the EOS dimensions are 120° horizontal, 60° up and 15° down (see the figure below). The radar beam scans an area 2.5° tall, requiring four passes to the cover the entire scan cone. Each pass takes about 0.5 seconds. Information on each radar contact, therefore, is updated every two seconds.



In BVR Mode, the radar antenna is stabilized in roll and pitch. This means that the direction of the antenna axis does not change when the aircraft banks, pulls up or dives, providing that the aircraft manoeuvres do not exceed the gimbal limits of the antenna. Unlike in many Western aircraft, the beam shape of the Su-27's radar is fixed and cannot be changed. The maximum detection depends on the target's characteristics (geometry, aspect angle, radar reflectivity, etc.). Typically, the radar can detect a medium-size target such as a MiG-29 at a range of about 100-120 km. Large targets such as strategic bombers can be detected at distances up to 150 km.

TARGET	MAXIMUM DETECTION RANGE IN SCAN SUB-MODE, KM
B-52	150
F-111	80
F-16	50
F-117	@10

As with the radar, the field of search of the electro-optical system is stabilized in roll and pitch. The EOS can detect medium-size targets located up to a maximum of 50 km. But, as described above, cannot accurately measure the range to a target beyond 5 km.

Tracking data appears on both the HUD and the MFD, depending on the mode and submode selected. In most cases, the MFD shows a top-down view of the area around your aircraft. Your current position is indicated by the small aircraft symbol; the number in the corner indicates the distance from the bottom edge to the top edge in kilometers. HUD and MFD symbology appropriate to each mode and submode are described in the following sections.

ДВБ (BVR) mode has three submodes of operation: Scan, Track While Scan, and Attack. The following sections describe each mode.

ДВБ – ОБЗ *(SCAN) Scan Submode*

Pressing the 2 key selects ДВБ (BVR) mode in the ОБЗ (SCAN) sub-mode of operation. This is your primary, long-ranged search mode. It detects contacts (depending on RCS) from 25 to 150km away, displaying up to 24 contacts on the HUD. This mode does not provide any detailed information about a specific contact. You'll know the azimuth (how far the contact is off your nose) and distance. You can also establish the contact's elevation by the correlating the image return and scan beam "illuminator" on the right side of the HUD.

4-8a: ОБЗ (SCAN) Submode

To gather more information about specific contacts of interest, steer the HUD target designator box over the desired contact (using the joystick coolie hat or the keyboard controls). Designate the target by pressing Tab key. If the contact is within the track parameters of the radar, the HUD switches to Track While Scan submode and the MFD will now display the designated contact. Aspect information relating to the contact can now be viewed on the MFD. Alternatively, pressing the 2 key immediately selects the eight closest contacts and switches to Track While Scan mode. You cannot enter Track While Scan mode without designating at least one contact in Scan mode.

ДВБ – СНП *(TWS) Track While Scan Submode*

The СНП (TWS) Track While Scan submode focuses the radar/EOS "attention" on up to eight contacts while continuing to scan and display range, azimuth, and elevation information on up to 16 others. The contacts on the MFD in TWS are continuously tracked by the radar.

On the HUD, a "tracked" contact changes from a dash to a small triangle. On the MFD, enemy aircraft are displayed by triangle-like symbols, friendly aircraft are represented by circular symbols and each tracked contact symbol has an aspect vector angle indicating direction and position relative to your aircraft. The MFD shows a top-down view of the area around your aircraft. Your Flanker's position is indicated by the aircraft symbol. The number in the upper corner of the MFD indicates the distance in kilometers from the bottom edge of the MFD to the top edge. The closer contacts are to the top edge, the farther away they are from your aircraft.

4-8a2: СНП (TWS) Submode

Attack (ATK) Submode

The Attack submode is common to all air to air modes. In short, you are requesting the radar to focus all its energy onto one specific aircraft contact. Depending upon which mode you are operating (BVR, CAC), the method of selecting or designating that contact differs, but the end result is the same: The radar/EOS will automatically track the aircraft contact, hence the term "auto-track." In common language this is called "the lock." The radar/EOS receives all the necessary contact parameters from the Weapons Control System to smoothly move the antenna in the direction of flight for the contact. The following parameters are available on the HUD while the radar is in auto-track:

- Aspect Angle relative to user aircraft
- Distance relative to user aircraft
- Azimuth/Elevation relative to user aircraft
- Speed of contact

Radar tracking area for a single target is 120°x 120° in elevation and in azimuth, and tracking range for a medium-size target is from 55 km (rear hemisphere) to 100 km (forward hemisphere for large aircraft). When operating in Attack Mode, the radar provides target designation for guided missiles, illuminates targets for missiles fitted with SARH seekers, and provides initial guidance data for active missiles.

If you use the EOS, the tracking area coincides with its field of search and equals 75° in elevation (15° down, 60° up) and 120° in azimuth. Tracking range depends on the type of target, strength of the heat signatures, and the attack hemisphere. The EOS laser rangefinder measures distances to the target for ranges from 0.2 to 3 km, with an accuracy of 10 meters and from 3 to 5 kilometers with and accuracy of 25 meters.

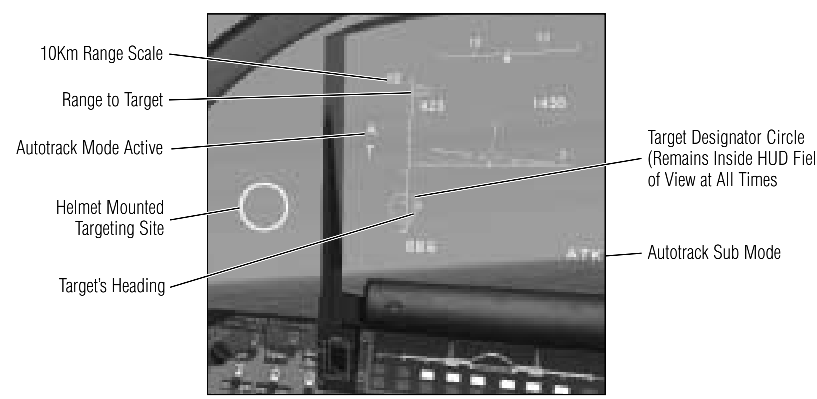
After the radar (EOS) has locked onto the target, the HUD shows the following information: the 'À' Autotrack Cue, the range scale with the minimum and maximum launch range marks, the range to target mark, and the target aspect angle arrow. The HUD also displays the Aiming Reticle, altitudes and true airspeeds of your aircraft and of the target, the aircraft datum and bank scale, current combat mode, type of missile, quantity of missiles, and missile flight time. The target's position is shown on the HUD as a point (the Target Marker) in angular coordinates scaled to the dimensions of the tracking area (see the figure below).

4-15: Autotrack Symbology with Radar Lock

Green lights on the Weapon Readiness Panel indicate which missiles at each weapons station are ready for launch. The MFD displays a top-down view of the target, its aspect angle, and distance-information about the target. When you are tracking the target using the radar, target information may disappear for some time if the target deploys ECM or decoy countermeasures.

The HUD will also display the ПР (in English the designator will be **LA** for "Launch Authorized") Shoot Cue or ОТВ (pronounced 'o-te-ve', stands for 'TURN AWAY' in Russian. In English the designator is **No LA** for "No Launch Authorized") Reject Cue. The Shoot Cue informs you that the selected missile is ready for launching and the target is within the missile's reliable launch parameters. Fire the missile by pulling the trigger (Spacebar). The Reject Cue warns that you are too close to the target and prohibits launch. If you lock onto friendly aircraft, the IFF (Ide СВОЙ and denotes "Ours").

If the radar or the EOS switches to autotracking from Helmet Mode, cross-hairs superimpose on the Targeting Circle (see the figure below). When the HUD gets the Shoot Cue, the Targeting Circle flashes at a frequency of 2 Hz. If the onboard computer does not get target range information, the Targeting Circle flashes with a frequency of 1 Hz (this is common when using the EOS).



4-17: Autotrack Symbology with Helmet Mounted Sight

When tracking a target in Attack Mode, manoeuvre your aircraft so that the Aiming Reticle stays close to the HUD centre datum. This eases your work load when the target is not very visible and prevents the target from breaking the lock. Remember, if you use the EOS, the flashing of the Shoot Cue with a frequency of 1 Hz warns you that the system is not measuring the range to the target.

Keep in mind that for SARH missiles, it is necessary to illuminate the target for the entire flight time of the missile. After launch this will be represented by the A (Auto-track) cue flashing at 1 Mz. So know your missiles!

If the target leaves the tracking area, or you break the lock by pressing the Tab key, or the target is destroyed, the radar (the EOS) returns to the submode which preceded the Auto-track. Similarly, if the radar or EOS is damaged or you switch sensors off, the lock breaks and the radar returns to the submode which proceeded the Auto-track.

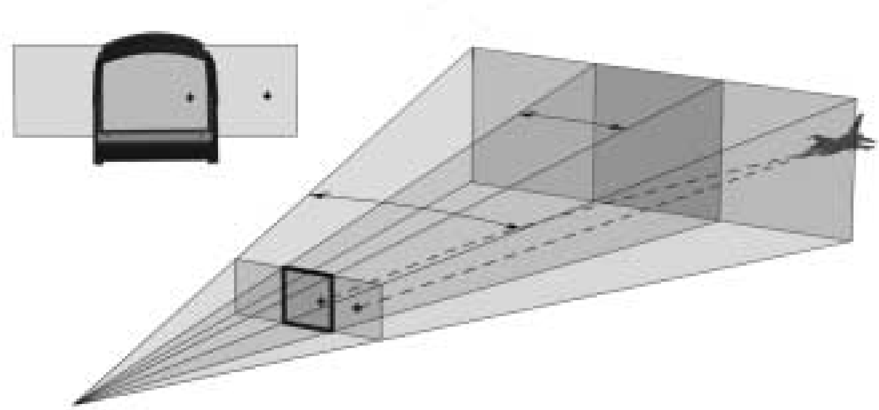
ДВБ – ДРЛО *(AWACS) AWACS Datalink*

The Flanker's ability to datalink with AWACS aircraft allows pilots to locate, stalk, and engage targets without ever engaging onboard sensors. This form of "stealth" lets the Flanker close on its prey without betraying its presence. A friendly AWACS aircraft (an A-50 or E-3) must be airborne simultaneously to your aircraft. The datalink information can be viewed on the MFD in all combat modes as well as the NAV modes, however, these contacts can only be selected for targeting from the BVR mode, with the radar and the EOS off. While in BVR mode, if there is a friendly AWACS aircraft airborne, a datalink will be established and contacts detected by the AWACS will appear on the MFD as standard aircraft symbols (friendly and enemy). The AWACS contacts will appear more subdued (less bright) than regular contacts. While in BVR mode you can use the ~ Key to cycle through AWACS contacts on the MFD. A selected contact will appear brighter. Use the Tab Key to lock up a selected AWACS target in Auto-track. Once you hit the Tab Key your radar will illuminate the target and you will no longer be passive.

4-8a3: ДРЛО (AWACS) Submode

HUD Scaling Considerations

Keep in mind that the scan zone for sub modes is larger than the area covered by the HUD. Targets are therefore "scaled" to fit the dimensions of the HUD. The target marker in the HUD, consequently, points toward the target but is not an accurate indicator of the target's azimuth and elevation. The gimbal markers on the MFD will give you a better idea as to how close the gimbal limit for the target is and you will easily interpret off boresight angle.



4-8b: Target Positions are Scaled to Fit the HUD

Acquiring A Target in ДВБ (BVR) Mode Step-by-Step

Let's walk through the process of acquiring a BVR target.

Step 1. Switch to BVR Mode

Press the 2 key and check that the HUD Mode Indicator shows the notation of the ДВБ – ОБЗ (BVR - SCAN). If there is a friendly AWACS aircraft airborne ОБЗ (SCAN) will be replaced by ДРЛО (AWACS). Use the + and – keys to adjust the range displayed on the MFD and the HUD.

If you have an AWACS datalink, then you will almost immediately receive contact data on the MFD: Friend or foe, distance, and aspect angle. (See above for more on AWACS). If this is the case, you can cycle through the contacts on your MFD by selecting the (~) key. Then go to step 5.

Step 2. Select a sensor.

Activate the radar or EOS. The notation at the left of the HUD should read И (I) or Т (T) for the radar and EOS, respectively. Alternatively, the HUD will display ДРЛО (AWACS) if a friendly AWACS aircraft is airborne and in range.

Step 3. Direct Scan Zone

Using the Shift - coolie hat on your joystick or the scan zone control keys, aim the scan cone in the portion of airspace you wish to scan. The HUD will immediately show detected contacts, if any.

4-9: The ОБЗ (SCAN) Submode Symbology

Step 4. Assigning Contacts to Track While Scan mode

To select a particular target, steer the HUD Target Designator Box (HTD Box) onto the contact of interest and press the Tab key. The contact will switch from being scanned to tracked. This method is called "manual selection" since you are selecting an individual contact to be tracked by the radar. The Weapons Control System also offer an automatic contact analysis routine whereby contacts with the highest closure speed/distance ration will become tracked contacts.

To automatically designate multiple scan contacts to the Track While Scan mode press the 2 key when there are multiple scan contacts displayed on the HUD while you are in ОБЗ (SCAN) mode. Up to 8 of the scan contacts will now be designated as track contacts and will now be displayed on the MFD.

To remove an individual contact from Track While Scan mode and place it back to scan, place the HTD Box on the triangle symbol on the HUD and press the Ctrl-Tab Key. The contact will be removed from the MFD and the triangle symbol will become a dash symbol on the HUD.

To remove all TWS contacts from the MFD and return to Scan mode press the 2 Key again and restart the sequence.

4-8a2: The СНП (TWS) Submode Symbology

Step5. Lock onto the target

To lock onto the selected TWS contact, press the Tab Key. If the lock parameters are met (aspect angle, Radar Cross Section, distance, speed, etc.), the radar (or the EOS) switches to Attack Mode. The Autotrack Cue (A) appears above the Radar Cue or the EOS Cue.

To lock onto a target if you have an AWACS datalink, select the Tab key.

It is recommend that you lock onto a target at a range that is close to a reliable range of the selected air-to-air missile. It gives the target less warning that it has been locked on and therefore increases your probability of scoring a fast kill.

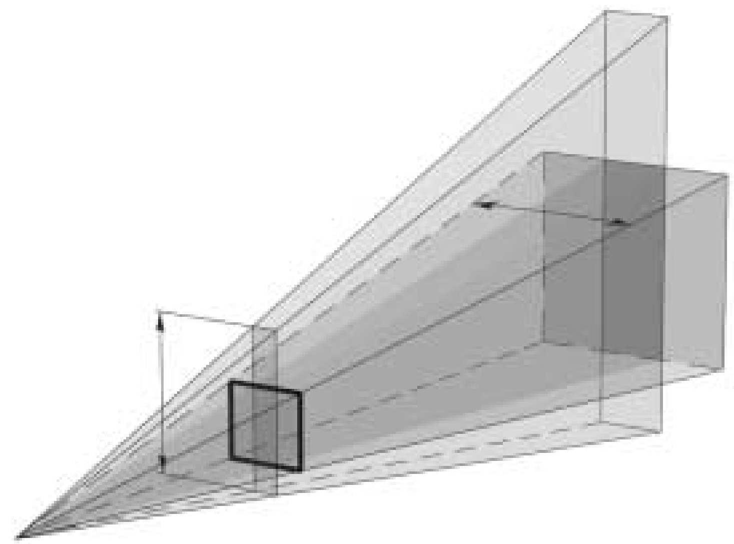
On the MFD the locked target will be illustrated by a solid triangle symbol, the target aircraft is now being illuminated by a 2.5∞ radar beam.

Step 6. Select Air-to-Air Missile and Launch

Select the appropriate air-to-air missile for the range and type of target by pressing the D Key. Consider range, manoeuvreability, size, and speed of the target. Once the target is within the launch parameters of the weapon and the launch cue is displayed in the center of the HUD, your are authorized to fire the weapon.

БВБ /Close Air Combat Mode

The БВБ (CAC) Close Air Combat mode is used for attacking targets which you have spotted visually or which are known to be within close range (less than 25 km). The radar (the EOS) locks onto a target in an area limited by the angular dimensions of the HUD, namely 20°x20° (±10° in azimuth and ±10° in elevation). The ШЛЕМ (HMTD) submode permits the pilot to acquire targets with greater off boresight angles.



4-10c: The БВБ Scan Cone

БВБ–BC (VS) Vertical Scan Submode

The first sub mode, called Vertical Scan submode and is depicted on the HUD by a narrow vertical band. This submode can be selected by pressing the 3 key. It is designed to acquire targets in a dogfight. Both radar and EOS are active, but this mode is very stealthy as the radar is not constantly emitting. It is “primed” and ready in a stand-by mode ready to send a very stong and fast scan along the 25∞/60∞ Vertical Scan cone. The HUD will display a P (which is the Russian R) on the left side of the HUD to denote “ready” or standby as well as the T for the EOS. Any contact detected and designated (locked) within the cone will immediately stop the scan process and focus a 2.5∞ circular beam on the target switching the submode to Attack (ATK).

Manoeuvre your aircraft so as to position the visually acquired target within the limits of the Vertical Scan Bar portrayed in the center of the HUD. The actual scan cone extends 20∞ above and behind the HUD. This means that you can lock a target even if you position it within that imaginary extended band. You can also steer the Vertical Scan cone (band) left and right 10∞ by using the target designator key commands.

4-10a: The Vertical Scan Mode Close Air Combat Symbology

БВБ–СТР (BORE) Boresight Submode

The second sub-mode, entitled Radar Bore Site scans in a narrow 2.5∞ circular beam, which can be steered up, down, left, and right (using the target designator controls) within the angular limits of the HUD, 20∞ x 20∞. This mode is used to focus the radar on a specific target, and is especially useful in crowded airspace. Activate the СТР (BORE) submode by pressing the 4 key. By steering the beam directly to the desired target, you reduce the risk of accidentally locking the wrong target. Similar to the Vertical Scan submode, the radar is not illuminating continuously but is on standby and primed to send out a strong circular pulse to the target. If the radar receives a return pulse the system switches immediately to Attack mode.

4-10b: The Radar Bore Site Mode Close Air Combat Symbology

Acquiring A Target

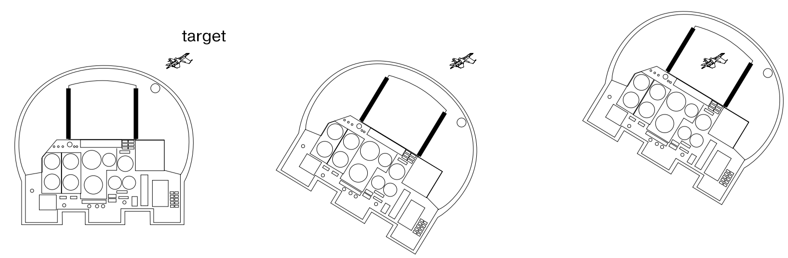
To acquire a target at close ranges, proceed as follows.

Step 1. Switch to CAC Mode

Press the either 3 or 4 to select the desired appropriate БВБ (CAC) submode. Make sure that the HUD Mode Indicator shows the БВБ (CAC) notation.

Step 2. Select a target

Once you have visually spotted a target, place it in the field of view of the HUD by manoeuvreing your aircraft and/or Vertical Scan or Boresight scan cones.



4-11: Moving the Scan Cone to the Target

Step 3. Lock onto the target

To lock onto the target, press Tab. Failing locking conditions, the Autotrack Cue flashes at a frequency of 2 Hz. In this case press Tab until **A** turns permanent. The radar/EOS switches to Autotrack Mode as evidenced by the change of information on the HUD and MFD. If several targets are within the field of view of the HUD, the equipment tracks the target that has been detected earliest. You may have to press Tab several times to obtain a lock.

ШЛЕМ (HMTD) Helmet Mode

This is also a Close Air submode that, while visually similar to the Boresight submode, is very different. This sub-mode can be activated by selecting the 5 key. The Helmet-Mounted Target Designation (HMTD) system frees the pilot from having to boresight his enemy by slaving the radar and the EOS to the helmet-mounted sight. Once you have acquired the target, the Helmet Mode allows you to keep your eye on the target at all times by turning your head in the direction of the target's motion. The real world system works by using a pair of head position sensors on the cockpit panel, on each side of the HUD.

The radar (the EOS) locks onto the target in an area limited by the 2.5∞ scan cone. The pilot should keep the cone within the limits of the radar/EOS field of search. That means that you cannot use your helmet-mounted sight to acquire and lock onto targets beyond the gimbal limits of the radar antenna or the IRST sensor ball.

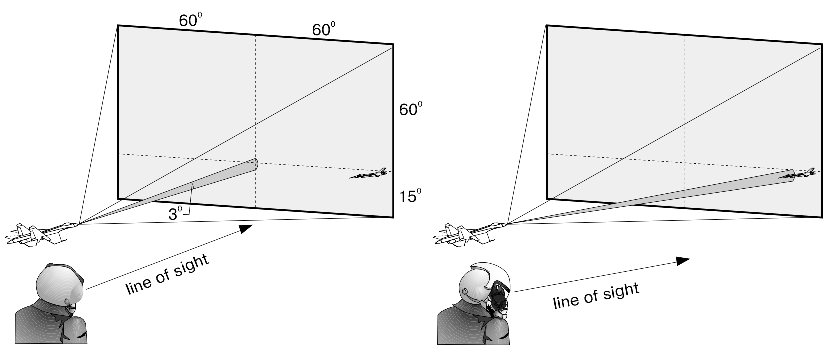
Acquiring a Target

Use the following procedure to lock a target with the ШЛЕМ (HMTD) mode:

Step 1. Switch to Helmet Mode

Press the 5 key. The HUD submode Indicator displays the notation ШЛЕМ (HMTD) (pronounced 'shlem', denotes 'HELMET' in Russian) on the lower right corner of the HUD. The Targeting Circle appears in front of you and follows the movement of your head.

Step 2. Select a target



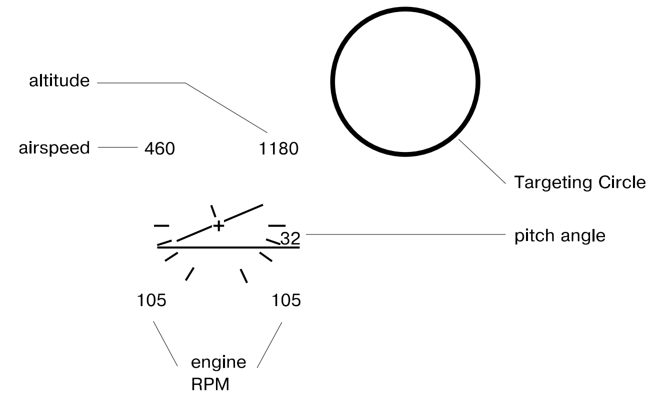
Caption 4-13: Steering the Scan Pattern with the Helmet Mounted Sight

Once you have visually spotted a target, place it within the Targeting Circle by manoeuvreing the aircraft and turning your head in the direction of the target. You can move your head using the joystick coolie hat or the numeric keys on the keypad. In so doing, the Targeting Circle moves with you head. The figure above illustrates how you search for a target when the EOS is slaved to the HMTD system. To padlock your eyes onto the target, press * (asterisk) on the keypad.

Step 3. Lock onto the target.

To place the HMTD onto the padlocked target, use either the joystick coolie hat or the scan cone keys. Once the circle is on the target press the Tab key. They HMTD is now padlocked to the target (along with your eyes) and the Weapons Control System is put into the Auto-track mode.

If the HUD gets out of view, a set of visual cues appears next to the Targeting Circle. These cues indicate your airspeed and altitude, the aircraft datum and pitch angle, and the engines RPMs (105% for both engines in the figure below).



Caption 4-14: Visual Steering Cues with the Helmet Mounted Sight

ФИО /Longitudinal Missile Aiming Mode

Should the radar or the EOS be damaged, you can still use the direct targeting capability of missiles fitted with IR or active radar seeker heads. This requires placing the target into the seeker's field of vision and locking on. The seeker tracks the target in an area limited by its gimbal limits and by the tracking range. The latter depends on the type of missile, type of target, and attack geometry.

Longitudinal Missile Aiming

You use the ФИО (LMA) Mode for attacking a visible airborne target in a dogfight, by selecting the 6 key. The missile seeker locks onto the target in an area limited by the angular dimensions of the seeker's field of vision (about 3°), which is aligned along the longitudinal axis of the aircraft. The seeker head locks onto the target within 2-3 seconds.

To lock onto a target in ФИО (LMA) Mode, perform the following steps:

Step 1. Switch to Longitudinal Missile Aiming Mode

To do this, press the 6 key. If the selected missile has a seeker head of an appropriate type, the HUD shows the fixed Aiming Reticle (3°) and the seeker aligns itself along the longitudinal axis of the aircraft. The Weapon Readiness Panel shows the selected missiles.

Caption 4-18: Longitudinal Aiming Mode Symbology

Step 2. Select a target
Once you have visually spotted a target, place it within the Aiming Reticle by manoeuvreing your aircraft.

Step 3. Lock onto the target
Enter targeting data into the seeker head by pressing the Tab key. If the locking conditions are met, the seeker locks onto the target and starts tracking it. We'll describe the Seeker Track Mode in a separate section below.

Seeker Track Mode

After a missile seeker has locked onto the target, it switches to track mode continuously keeping the target within the seeker's field of view. The dimensions of the single target tracking area depend on the type of missile and are limited by the gimbal limits of the seeker head and sensor sensitivity. Gimbal limits may range from 20° (the R-60 Aphid) to 80° (the R-77 Adder). Tracking range depends on type of target and specifications of the seeker head and may vary between 5 km and 30 km.

When the seeker tracks a target the HUD shows the following information: altitude and true air-speed of your aircraft, aircraft datum and bank scale, type of missile and quantity. The HUD Mode Indicator displays ФИО (LMA). Lock onto the target is evidenced by the movable Aiming Reticle showing an angular position of the seeker head and by the Shoot Cue ПР.

You should manoeuvre the aircraft so that the movable Aiming Reticle stays close to the HUD center datum. This eases aiming at the target and prevents the target from breaking the lock.

If the target leaves the tracking area of the seeker head, or you break the lock by pressing Tab, or the target is destroyed, the HUD returns to the mode which immediately preceded the track mode ФИО (LMA).

Using the GSh-301 Cannon

Regardless of the combat mode selected, (BVR, CAC, LMA, or Helmet), you can enable your GSh-301 cannon at any time by pressing the C key. Depending on whether or not the radar (EOS) has been locked onto the target, the gunnery with the cannon can be performed:

- with targeting from the radar or the EOS
- without assistance from the radar or the EOS.

For more information on using the cannon, refer to the "Weapons" chapter.

AIR-TO-GROUND COMBAT

The Su-27, is primarily an interceptor The carrier-based Su-33, however, is designed as a multi-role, aircraft.

- Ground target work may be conventionally divided into the following steps: search, identify, and attack. If a target you are searching for cannot be spotted visually, use your radar, which helps to acquire targets at long ranges and where appropriate download the target coordinates into the Weapons Control System (WCS). The appropriate aircraft bomb and missile payload depends very much on the type of mission planned and expected targets. For information on using air-to-ground weapons, see the "Weapons" chapter.

To switch the onboard systems to Air-to-Ground (A2G) Mode, you should press the 7 key and check that the HUD Mode Indicator reads ЗЕМЛЯ (Russian designation for GROUND, pro-nounced 'zem-lja'). To control your weapons and onboard systems in A2G Mode, you use nearly the same keys as in the air-to-air modes:

KEY	ACTION
I	Toggle radar
O	Toggle TV Seeker On/Off (if TV guided missile is present)
`	Select next assigned target on MFD
Tab	Lock on/off target
; (Semicolon)	Move radar/TV scan zone DOWN
, (Comma)	Move radar/TV scan zone LEFT
. (Period)	Move radar/TV scan zone UP
/ (Slash)	Move radar/TV scan zone RIGHT
Ctrl+I	Center radar antenna/IRST ball
- (Minus)	MFD zoom in
+	MFD zoom out
D	Cycle through weapons
C	Activate/deactivate cannon
Ctrl+V	Toggle Salvo mode
Ctrl+W	Jettison all weapons
Spacebar	Fire current weapon

*Note that selecting the cannon temporarily disables all other ground weapons systems and targeting.

ЗЕМЛЯ (GRND) Air-to-Ground Mode

In A2G Mode the Miech-33 radar scans ground surface within the limits of its field of search of angular dimensions of 120°x120° in a range of 3-150 km. The maximum size of the scan zone along the flight path is limited both by the maximum deflection angle of the radar antenna (60°) and by its inclination angle with respect to the horizon (3°). Linear dimensions of the field of search depend on your altitude - the lower you fly, the smaller the dimensions of the field of search.

The A2G mode offers three different scan patterns designed to scan different size areas at varying degrees of resolution. These three scan patterns cycle from a broad, low-resolution search beam to a highly-focused, high-resolution pattern. Use the + and - keys to switch between resolutions.

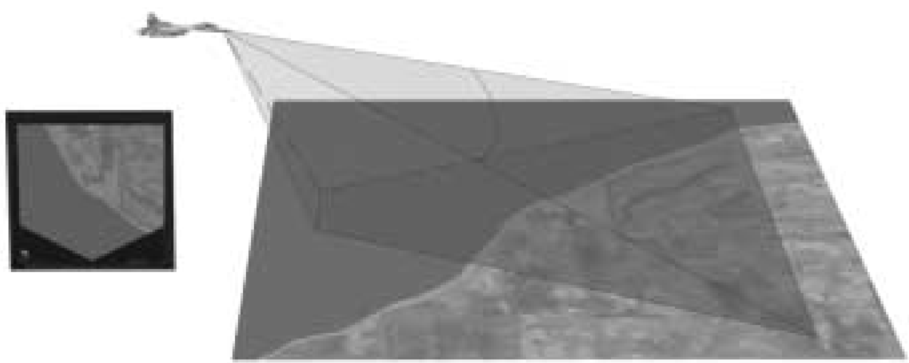
When you activate the radar in A2G Mode (the **I** key), the И Radar Cue and the Radar Designator diamond appears on the HUD. The radar starts operating in a Scan Mode.

MFD

If the radar is not active, the MFD shows a navigation display, similar to the one used by the МАРШ (ENR) navigation mode. Besides waypoint and flight path markers, predesignated targets are also displayed. Use the ` key to cycle through the targets. Once the radar is activated, the MFD displays a radar-generated map. The following sections describe the details of the MFD ground radar display for each submode.

Scan Submode

This mode provides for coarse mapping of the terrain laying dead ahead. In the Scan Mode the 60∞ scan cone can be controlled by orienting the radar antenna (the scan cone) in the vertical plane +/- 30∞ and in the horizontal +/- 30∞. The antenna is stabilized in roll and pitch. However as your heading changes, the scan zone moves so that its center is always lined up with the aircraft's longitudinal axis.



4-22: The Scan Mode Search Pattern

The MFD processes radar information into a synthesized image of the terrain as if you were looking at the ground map from above. Two V-shaped indexes, one to the left and another at the top of the MFD, show the position of the scan zone center with respect to the aircraft's longitudinal axis. Distance to the center of the scan zone in kilometers is shown in the lower left-hand corner of the MFD. You can move the scan zone center farther or nearer with the coolie hat on your joystick or with the vertical radar/TV scan zone control keys Period (.) and Semicolon (;).

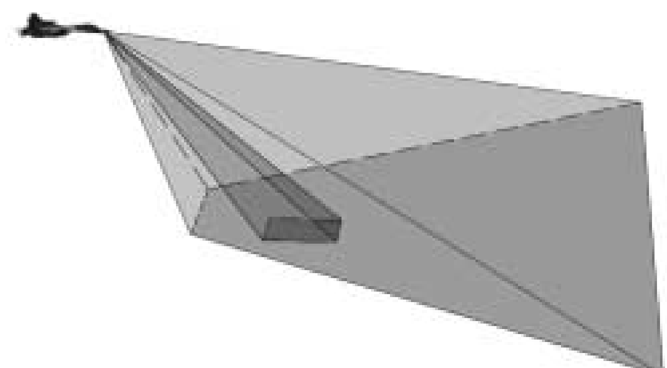
The diamond-shaped Radar Target Designator on the HUD represents the direction of the scan zone center. If the Radar Target Designator goes beyond the limits of the HUD, the diamond is overlapped by the 'X' symbol and stays near the edge of the HUD.

4-23: The Scan Mode Symbology

After you have selected an area of interest using information shown on the MFD, you can narrow your search by switching the radar to Search in Wide Area (SWA). To do this, press the + key.

Search in Wide Area (SWA)

Pressing the + key in scan mode focuses the surface mapping mode on a smaller area, magnifying the view 20 times.. In the SWA Mode the radar scan zone has angular dimensions of about 10°x10° and moves with the aircraft.



4-24: The SWA Search Pattern Within the Total Scannable Area

Information on the HUD is similar to that of the Scan Mode. The MFD shows an enlarged synthesized image of the terrain with the Narrow Search Area (NSA) frame (see below) in the center. Again, the number in the lower left-hand corner of the MFD shows distance to the center of the scan zone. (center of the NSA frame).

4-25: The SWA Symbology

You can control the position of the scan zone center as to angles in vertical and horizontal planes with the radar/TV scan zone control keys. Once you have placed the NSA frame on your desired search area, switch the radar to Search in Narrow Area (SNA) Mode by pressing the + key again. You may return to Scan mode by pressing the – key.

Search in Narrow Area (SNA)

SNA is the most focused, detailed ground mapping mode, magnifying the display 64 times and is used to locate and lock ground targets. In the SNA Mode the angular dimensions of the scan zone are 3°x 3. You control the scan zone in much the same way as in SWA Mode, however, the scan zone center does not move with movements of the aircraft, since the radar tracks a certain point on the ground or water surface.

The SNA Mode refers the position of your aircraft to the selected coordinates on the ground. Even if the line of sight to the selected point moves beyond the field of search, the radar will resume tracking that point as soon as this becomes possible. Locking on a point provides accurate target designation for anti-ship missiles and facilitates sighting for other types of ASMs, bombs and unguided rockets in conditions of poor visibility or at night.

4-27: The SNA Symbology

The MFD shows a synthesized image of the terrain with cross-hairs in the center of the search area. Using information on the MFD, you select a target (building, bridge, vehicle, etc.) by placing the cross-hairs on the target with the joystick coolie hat or the radar/TV scan zone control keys. You can also target visually by superimposing the Radar Target Designator on a target of interest. Thus, the diamond in the SNA Mode always points to the designated target.

Once you have placed the cross-hairs on the target, lock the position by pressing the TAB key. You can break the lock by pressing the TAB key a second time.

If you have no flight simulator expertise or if you have any difficulties piloting the Flanker, this chapter is just what you need. In this chapter we'll not take too close a look at the theory of flight, but we shall give you the minimum of information necessary to understand the terminology and the description of techniques and nuances of piloting.Though we do not have intentions to prepare you for demonstration flights during exhibitions in Le Bourge, in this chapter we do explain how to execute some aerobatics on the Su-27. Here you can obtain further insight into the delights of a realistic flight simulation and will be able to feel yourself not only as a first-rate hunter, but as a real jet jockey. The Su-27 lets you work wonders in the air. You will see it yourself when you manage to do such famous aerobatics manoeuvres as the "tail slide" and "Pugachev's Cobra". The latter manoeuvre not only has aesthetic value, but can also be effectively used in air combat.

Primary Forces and Angles

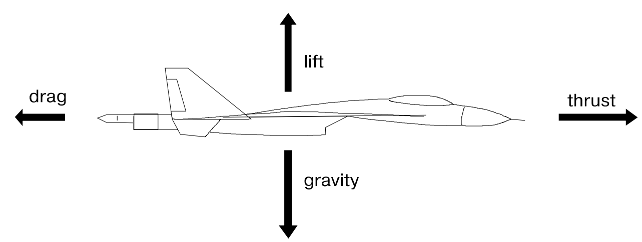


Figure 5-1: The Four Forces of Flight

You've probably read all about the four forces of flight: lift, drag, thrust, and weight, as illustrated in Figure 5-1. Working within the limitations imposed by these forces, the pilot manoeuvres the aircraft through space by manipulating pitch, roll, and yaw. Figure 5-2 illustrates these three motions and the angles used to measure them.

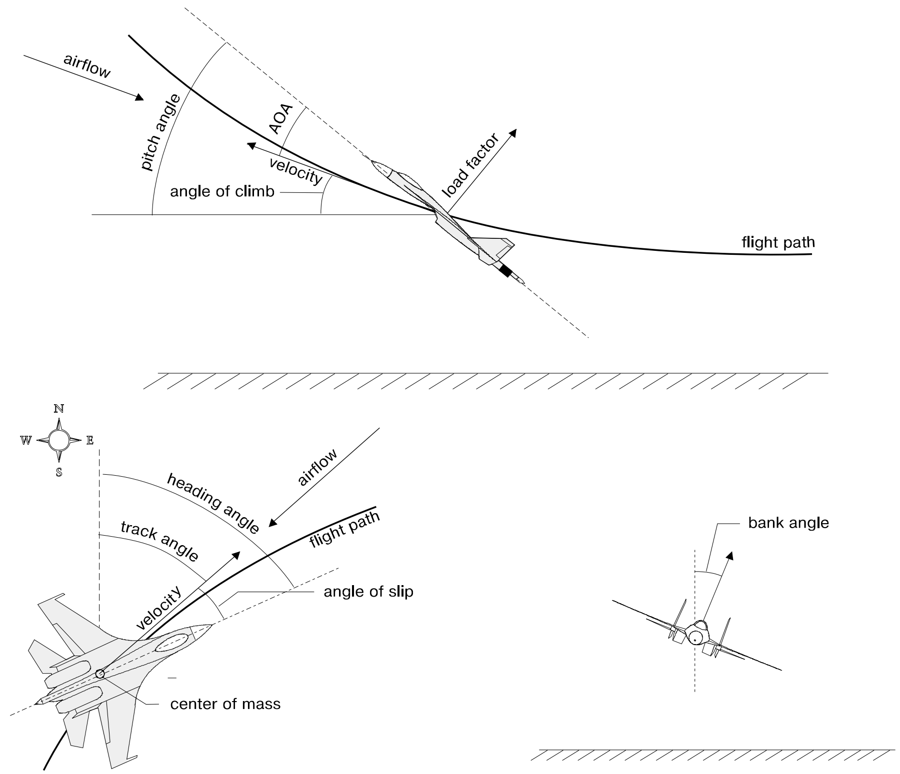


Figure 5-2: Pitch, Yaw, and Roll

To describe these various angles, it is more convenient to use the vector of velocity rather than direction of air flow as a frame of reference. The velocity of the aircraft is always opposite to the direction of the air flow and equal to it in the absolute value. The flight path is a trajectory of motion of the aircraft's center of mass, that is the point where all the forces acting upon the aircraft are applied. As you can see, the direction of motion at any particular moment doesn't always coincide with the aircraft's longitudinal axis.

The angle of attack (AOA) is the angle between the aircraft's longitudinal axis and the direction of its motion, i.e. the velocity vector. Up to a certain degree, the greater the AOA, the greater the lift and drag, and hence the increase in thrust required to maintain a constant speed. If the aircraft flies at a high AOA, the airflow cannot conform to the upper surface of the wing and forms turbulent vortices. The wing starts to lose its performance, maybe resulting in a dangerous stall or spin and, probably, in a catastrophe.

The pitch angle measures the angle between the horizon and the aircraft's longitudinal axis. Note that pitch angle is not the same as the angle of climb which indicates the angle between the air flow (or velocity vector) and the horizon. This angle is also called flight path angle, which when added together with the AOA constitute the pitch angle. Therefore, in level flight the angle of climb or flight path angle is equal to zero.

Slip angle is another important angle describing aircraft motion. This angle characterizes the asymmetry of airflow passing over the aircraft. This angle sometimes may coincide with the yaw angle. The difference between these two angles is illustrated in the figure below.

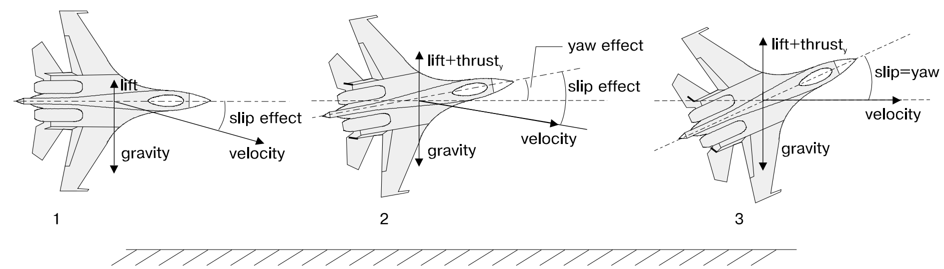


Figure 5-3: Slip Angle

All three aircraft are flying in the vertical plane in knife edge. Aircraft 1 is sideslipping towards the ground since the gravity force is greater than lift. The pilot in Aircraft 2 applied some left rudder so that the vertical component of thrust is added to lift and the aircraft develops yaw. Here the aircraft is still going towards the ground but slower. The pilot of Aircraft 3 deflected the rudders farther so that the aircraft is moving straight and level (the gravity is fully compensated by thrust and lift). In the third case the slip effect coincides with the yaw effect.

The Edge of the Envelope

A combat pilot, simulated or otherwise, does not whip out a slide rule during a dogfight and calculate the variables influencing the outcome. The pilot, does, however, need to understand the basic principals which dictate the flight envelope and what actions on his part will improve or degrade flight performance.

Angle of Attack and Stalls

As explained earlier, angle of attack (AOA) represents the difference between where the aircraft is pointed and where it's actually going, and is largely the result of momentum. AOA increases anytime the pilot pitches the aircraft, including when initiating a climb or dive. Moving the control surfaces causes the aircraft to rotate about its pitch axis and point in a new direction. Momentum keeps the aircraft moving along its original heading until the thrust from the engines and lift can push the aircraft in the new direction. Decreasing engine power during level flight also increases AOA. As the aircraft slows, it generates less lift and gravity begins to pull it down while the nose remains pointed near the horizon.

AOA and airspeed impact the amount of lift (g load) generated by the wings. Generally speaking, if the wing isn't stalled, then increasing AOA will increase the amount of lift being generated. Likewise, increasing speed while holding a constant AOA will also increase lift.

Increasing AOA too much, though, will disrupt the airflow over the wing and reduce the amount of lift being generated. This is called a stall. A stall can occur at any altitude, airspeed, and flight attitude. An aircraft travelling at 1000 km/hr will stall if the pilot exceeds critical AOA. The pilot wants to maximize the amount of lift being generated, and subsequently tries to increase AOA. Pushing just a fraction too far, though, stalls the wing and greatly decreases lift.

Lift, Turn Rate, and Turn Radius

The lift vector (the direction of the generated g load) is perpendicular to the wings. Banking the aircraft, as shown in figure 5-3, reduces the amount of lift directly opposing gravity.

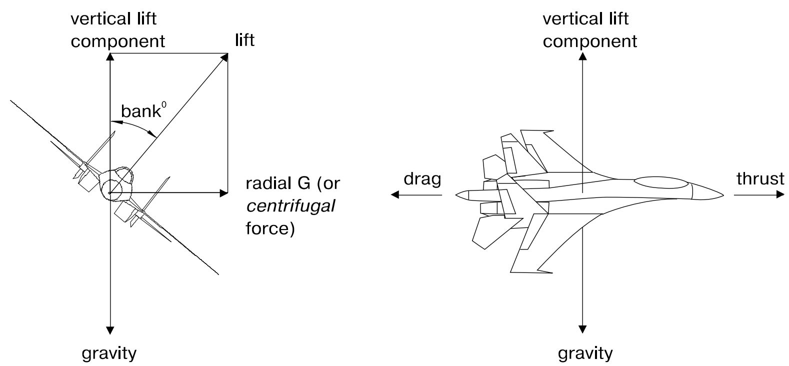


Figure 5-4: How bank angle affects g-load

Turn performance is generally described in terms of turn rate and turn radius, both of which are dependent upon the aircraft's speed and the amount of lift, or g-load, being produced. Turn rate measures the speed at which the nose is moving around the circle, typically measured in degrees per second. A high turn rate, therefore, means the aircraft could complete a 360-degree turn very quickly. Turn radius, as the name implies, measures the size of the aircraft's turn. The ideal fighter would have a very high turn rate coupled with a very small turn radius.

Turn rate is largely determined by g-load divided by airspeed. A high g-load increases turn rate while a high airspeed decreases it. Turn radius is primarily determined by airspeed squared divided by g-load.

Therefore, increasing airspeed quickly increases the turn radius while increasing g-load reduces turn radius.

Putting It All Together

We can now see how all the pieces fit together. Increasing the AOA increases the amount of lift being generated until the wing finally stalls. Increasing the g-load, meanwhile, improves both turn rate and turn radius. Unfortunately, increasing AOA also increases drag, and slows the aircraft down. This in turn reduces the g-load available and decreases turn performance.

Airspeed, meanwhile, is a two-edged sword. For a given AOA, increasing airspeed increases the amount of g-load being generated. That helps turn performance. Unfortunately, as we see from the turn rate and turn radius equations, increasing airspeed actually decreases turn performance. Further, keep in mind that lift is a "bounded" quantity; the pilot and airplane can only handle so much g-load before blacking out or breaking, respectively. We can see from the equations that pulling 8g at 1000 km/hr will result in worse turn performance than pulling 8g at only 750 km/hr. Increases in speed while g-load remains constant can only hurt turn performance.

Energy Management

This brings us to the topic of energy management. No pilot whips out a slide rule during battle to calculate turn performance. Instead, the pilot relies on an understanding of the concepts presented here and how to utilize them in the real world. In other words, the pilot learns to manage the aircraft's energy by applying the principles discussed thus far.

What is Energy?

So, what exactly do we mean by "energy," anyway? By and large, "energy" refers to either airspeed (kinetic energy) or the ability to increase airspeed by diving from a higher altitude (potential energy). Despite the fact that airspeed degrades turn performance, we have to have sufficient airspeed to generate g-load. The goal, therefore, of energy management has two parts. First, we want to have enough airspeed available to generate the desired amount of g-load when we need it. Second, we want to keep airspeed to the bare minimum needed to achieve that desired g-load.

Instantaneous and Sustained Performance

The question, of course, is how exactly does one manage energy? Try thinking of energy as the "money" that the aircraft uses to "buy" manoeuvres. Like most of us, the aircraft has a very limited budget. Through careful allocation of funds, we can buy the staples we need as well as an occasional large item, like a car or television set. Carelessly spending funds with little forethought usually leaves us broke just when we need money the worst. We'll now examine the types of energy the aircraft has to spend and the various ways to distribute it.

The aircraft has two main sources of energy. Airspeed, or kinetic energy represents "cash" in our money analogy. Manoeuvreing requires speed, which comes primarily from the engines' thrust. Altitude, or potential energy, can be quickly converted to additional airspeed by diving.

When it comes to "spending" that energy, we talk about Instantaneous and Sustained performance. Instantaneous performance refers to the maximum turn performance the aircraft is capable of, usually at the maximum g-load available. It only lasts for a brief moment, though, as high g-loads generate substantial drag, which quickly slows the aircraft. Sustained performance refers to the "steady state" performance of the aircraft when engine thrust reaches equilibrium with drag. Sustained performance will be well below the instantaneous performance; theoretically, the aircraft could maintain this steady state until it runs out of fuel.

▶ **G-load Limits**

The FLCS of the Flanker limits positive and negative Gs to +8.5 and -2.5, respectively. However, the aircraft can be flown to +9 and -3 Gs and has design structural limitations of +15 and -5 Gs (though the aircraft's systems will surely be damaged of such high G-loads).

Corner Speed

Corner speed is the airspeed which produces the highest turn rate with the smallest turn radius. It doesn't necessarily produce either the best turn rate or turn radius, but rather the best combination of the two. Pilots generally try to maintain this speed during a turning fight (see Energy Management Examples later in this chapter). This speed varies as a function of weight and external stores drag, but in general, is situated between 550-680 km/hr.

Energy Management Examples

Let's take an example of how all of this impacts a dogfight. As an engineer and simulated combat pilot, I'm probably more interested in estimations than exact figures. We'll begin with guns-only examples while we examine some basic aerodynamics of dogfighting, then we'll see how off-boresight missile capability affects things

Generally, I begin by setting a target airspeed. The exact value varies based on the type of fight I'm in and my goals. Suppose I'm in a guns-only fight against a single Su-27.I'm in a fairly offensive position, with my opponent being roughly 45 degrees off my nose. My airspeed is 850 km/hr and we're in a nose-low turn. The target wasted much of his energy earlier in the fight and is moving much slower than I am, say around 400 km/hr. I have a fair amount of energy in this situation, so I make the decision to pull hard on the stick. I'm pulling maximum g, my speed is bleeding off, but my nose is rapidly pulling toward my adversary. I pull him into view and shoot the GSh-301 30-mm cannon.

This tactic relies on the instantaneous turn performance. I set my target airspeed as being around my stall speed and used the excess speed and spend all my energy to purchase one hard turn. If I can pull 9g but the target can only pull 2.5g, then I have a huge turn performance advantage which I can utilize to quickly bring the nose to bear. Now I have to make that turn count. Basically, I'm trading all the energy I have available for one hard turn toward the target. This is going to bleed a lot of speed and leave me without much energy. If I manage to down my adversary, then it's not much of an issue. If I miss the target, or if he has a wingman sneaking into position behind me, then I have a big problem. I'm left wallowing around the sky at or near stall speed. If there are no other bandits, then it doesn't really matter much. In a combat situation, though, you never know when another bandit or a SAM site will suddenly pop up and start taking pot-shots at you. Although I may have won this particular engagement, this is not necessarily the smartest tactic.

Backing up to the start of this scenario, I change my mind and decide not to bleed away all of my energy. I instead decide hold my airspeed at or near corner speed. I decide that I need to maintain about 700 km/hr. Therefore, I can't pull as much g. If I do, the extra drag will slow my aircraft below the desired speed. In this example, perhaps I can pull 5g without bleeding below the desired airspeed. I should still have a turn performance advantage, but it'll take longer to bring the nose to the target. If my speed starts to bleed away, I increase power. If I'm already at full afterburner, then I

have to lower the g by letting up on the stick a little bit. If the speed starts to climb I can then increase the back pressure and g-load again. If my speed still increases, then I pull back on the power a little. After I shoot him down, I'll still be moving at a reasonable speed and able to execute defensive manoeuvres (or escape). Of course, everything has a tradeoff: since it takes longer for me to bring the cannon to the target, I'm giving other potential adversaries more time to attack me.

Now, let's add a twist to the scenario, with target Su-27 moving at 650 km/hr. I have the same choices as before: spend all of my energy in one shot or not. I can still pull hard on the stick in one last-ditch effort to bring the nose to bear, but I don't have much (if any) energy advantage now. If I can't bring the nose to bear before I stall out, or if I happen to miss the shot, I'm left in a sorry position against a strong adversary. In this case, I might decide to keep my speed around 700 km/hr and be patient. If I don't make a mistake, I'll gain angles slowly but surely (probably using yo-yo manoeuvres to expedite the process) until I either gain enough to take a shot or he makes a mistake and gives me a decisive advantage. As with the second example, this process consumes time but conserves energy. Flying patiently, I can slowly gain angles on the target. Then, at the last minute I can pull harder to bring the guns to bear. I'll still bleed speed when I increase the turn, but not nearly as much as in the first target.

Suppose, however, the target has the energy advantage or is a nimble dogfighter like an F-16. Entering a sustained turning fight is the last thing I want to do. I'll be pulling max g and losing speed like crazy while he "walks" up my canopy toward my six o'clock position. In this case, I decide to keep my speed high, execute low-g slashing attacks. I become very gentle with the stick, being very careful not to pull to many g and waste speed. An F-16 pilot will often bleed all of his speed in one or two early turns as described above in the first example. The F-16 is a great dogfighter, and this tactic often works well for it. If, however, I can keep my energy high and make him waste his advantage early, I have him right where I want him. As he executes a high-g turn toward me, I light my afterburners and begin a hard climbing turn. Because he bleeds so much energy in his turn, he has a hard time bringing his nose up to climb with me. I maintain just enough turn to keep the aspect angle high enough that he can't shoot a Sidewinder missile at me. The longer he keeps his nose high, the more he decelerates. Eventually, he'll have to either push the nose down or stall. As his nose points toward the ground, I roll in behind and finish him off.

Too Much Energy

Energy management isn't just about keeping speed high. While in most cases a combat pilot can't get enough energy, occasionally a pilot winds up with more energy than he knows what to do with. For example, suppose I'm flying very efficiently and maintaining the desired 700 km/hr but the bad guy is gaining angles on me. It's great that I'm managing my energy so well, but it's obviously not winning the fight and I need to think about working the aircraft harder.

In another case, after the fight I find that I'm still doing 500 km/hr at 5,000m. Looking down, I see another F-16 about 1,000m above the ground. These dogfights are wearing me out, and I'm not thinking too clearly now. I light the afterburners and execute a slit-S toward the unwary F-16. Unfortunately, I'm not paying much attention to my airspeed and I quickly accelerate to 1,000 km/hr. Such high speed causes me to have a very large turn radius, so I pull back harder on the stick to increase g-load. Several things happen. First, I start blacking out under the g-load. This is not going to help the situation. Second, gravity is now opposing me. It's helping me accelerate more plus it's pulling against the g being generated by my wings, both of which degrade my turn performance. I'm making a huge arc in the sky as I dive on this F-16, and as I approach 3,000m I realize I'm not turning near tight enough. It's clear that I'll pass beneath the F-16. If I pull harder, though, I'll black out completely.

About this time, I realize that the ground is coming up awfully fast. I realize that with this speed, I can't physically handle the g-load necessary for a safe turn. My turn radius is too large and I smack right into the ground. In this case, I blew the energy management by converting my altitude (potential energy) into too much speed (kinetic energy). My turn performance suffered and I crashed.

Energy Management in a Furball

The Western term, "furball" describes a large, multi-aircraft, chaotic dogfight. It's generally safe to assume that while you're stalking one target, one of his companions is stalking you. In such a fight you need to ensure that you've got the energy to make defensive manoeuvres when needed. Further, separating from the fight is far from a given. Just because you decide you've had enough and want to head home doesn't mean the bandit on your six is willing to let you go. Opportunities to escape are few and far between; when one presents itself you'd better have enough energy to take advantage of it.

Let's throw three more F-16s and three more Su-27s into the fray described earlier. Now, I have to keep my eyes peeled both forwards and backwards. It's not enough to watch the target that I'm tracking; I must keep an eye out for the bandit sneaking up behind me. The most basic of defensive manoeuvres, the break turn, relies on instantaneous turn capability to quickly increase the aspect angle between the defender and the attacker. If I'm floundering at 200 km/hr with a bandit moving in for the kill, I simply don't have enough energy to execute any kind of reasonable break turn. Therefore, I choose to maintain an airspeed at or near corner speed throughout the fight. If I'm saddling up on a target and starting to increase the g-load, I carefully watch my airspeed. If speed drops too much, I'll increase power. If speed continues to drop, I have no choice but to relax the g, roll out, and accelerate, even though it means letting the target escape. By keeping my speed up, I have the energy to execute hard defensive turns when necessary.

When defensive, try not to over react. Just because there's a bandit behind me doesn't necessarily mean I need to execute a 9g break turn. Imagine an F-15 chasing my Su-27 around a turn circle. The bandit's nose position indicates how high a threat he presents. If his nose is pointed well behind mine, then he most likely is lagging behind me and unable to take a shot. As his nose moves toward me (and eventually points ahead of my flight path), I know he's moving into position for a gun shot. I'll relax the stick, lower the g-load and accelerate while his nose is "off." As I see his nose pulling up for the shot, then I increase aft stick and tighten my turn. As soon as I see his nose fall back, I again release the stick and accelerate. By using my energy efficiently, I can stave off the F-15's attack for quite some time. If I can keep him at bay for just 20 more seconds, maybe he'll run out of fuel, maybe he'll see an exit window and leave the fight, or maybe my wingman will come to my rescue.

Helmet Mounted Sight and Off-Boresight Missiles

Finally, these examples should illustrate the huge tactical advantage ШЛЕМ head-tracking avionics coupled with the R-73 (AA-11). The ШЛЕМ mode lets you lock onto targets well above your nose, and the R-73 (AA-11) missile can engage targets up to 60 degrees aspect angle, giving the Su-27 a huge energy advantage in a knife fight. While I must still manoeuvre reasonably well, the decisions I faced in the first two examples diminish. Rather than expending energy in a hard turn to set up a shot, I simply lock the target using ШЛЕМ and fire an R-73 (AA-11). I pull fewer g's during the fight, keep my speed higher, and have more energy available for subsequent manoeuvreing. The ШЛЕМ system is by no means the be-all and end-all of air combat. The Su-27 is far from invincible (as demonstrated by repeated dogfights with ШЛЕМ -equipped, West German MiG-29s), but the system reduces the energy/manoeuvreing demands encountered during a dogfight.

COMMON FLIGHT TASKS

Pilots must learn their aircraft inside and out. We've included checklists for most procedures and emergencies you're likely to encounter. To practice these procedures, fly the training missions. For more information, see Flight Training later in this chapter.

Takeoffs

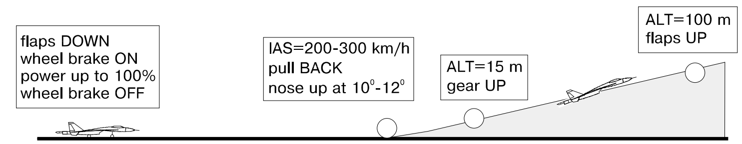


Figure 5-5: Typical Takeoff

Normal Checklist

Takeoff does not usually present too many difficulties, even to beginners. In due course, this procedure will become second nature and will not require much attention. To practice takeoffs, refer to the appropriate training mission in the Flight Training section.

Normal Takeoff Procedure:

1. If vehicle weight exceeds 25,000kg, extend flaps to take-off position (15 degrees down)
2. Engage wheelbrakes
3. Increase throttle to full military power, or the МАКС position.
4. At 100% RPM, release wheel brakes
5. If vehicle weight under 25,000kg, rotate at 250km/hr. Main gear should lift at 280km/hr.
6. If vehicle weight exceeds 25,000kg, rotate at 280km/hr. Main gear should lift at 320km/hr.
7. Raise gear when altimeter shows a positive rate of climb.
8. When altitude reaches 100m, raise flaps.

Engine Failure on Takeoff

Single-engine takeoffs are extremely dangerous. You can over run the runway without getting airborne or crash shortly after takeoff due to insufficient lift. Should an engine fail during takeoff, depend on the takeoff weight of the aircraft, length of runway remaining, and the height of obstacles beyond the opposite end of the runway. The following table shows the likelihood of completing a takeoff based on takeoff weight. As you can see, the odds are poor in the best of conditions and get increasingly worse as weight increases.

Table 5-1: Single-Engine Takeoff Success Probabilities Based on Gross Weight

VEHICLE WEIGHT	PROBABILITY OF SUCCESS
Under 20,000kg	Good
20,000kg to 25,000kg	Remote
over 25,000kg	Extremely Unlikely

Under 25,000kg the aircraft will usually become airborne. The problem is keeping it airborne long enough to land again. A single engine barely has enough power to keep the aircraft aloft, turning or climbing only makes the situation worse. As long as airspeed remains over 320km/hr the aircraft will probably remain airborne. Pilots must fly very carefully with very smooth stick inputs and the rudder trim correcting for dead engine yaw. The slightest over correction or mistake will result in disaster. Remember, keep the turn-and-slip indicator's ball centered.

The best option is to abort the takeoff roll. An Su-27 requires a 620m landing roll. To prevent running off the far end of the runway, reduce acceleration immediately. The following checklist describes the procedure for decelerating:

Aborting Takeoff Procedure

1. If less than 600m of runway remains or speed exceeds 270 km/hr, either proceed with take off or eject.
2. Immediately reduce power.
3. Engage wheelbrake.
4. Deploy drag chute.
5. Deploy flaps and airbrake

If aborting the takeoff is not an option, increase to full power and use all available runway to accelerate. Do not rotate until the last moment. Once airborne, jettison all external stores immediately and climb. Use the following checklist to maximize chances for success:

Single Engine Takeoff Procedure

1. Lower flaps to takeoff position. Increase all specified speeds by 30 km/hr if flaps are unavailable.
2. Apply full power.
3. For launch weights under 25,000kg, rotate at 280km/hr. Main gear should lift at 320km/hr.
4. For launch weights over 25,000kg, rotate at 320km/hr. Main gear should lift at 360km/hr. Single engine takeoffs are not recommended for aircraft weighing over 25,000kg.
5. Apply rudder toward the good engine to counter yaw.
6. Raise gear at positive rate of climb (ROC).
7. Immediately jettison all stores (clear of built up areas).
8. Maintain a level climb to 1,500m. Do not bank the aircraft.

9. After reaching 1,500m, evaluate the situation. If possible, execute a 1.2g turn back to the airbase and land (Use 330 km/hr as the minimum approach speed).
10. If speed drops below 250km/hr, eject immediately.

▶ **Fly the plane first**

Although pilots should try to notify the tower of their situation, the pilot's first responsibility is to the safety of the aircrew and aircraft. If you're too busy to talk, then don't. Fly the plane first and worry about everything else later.

Landing

Landings often distinguish the good pilots from the mediocre pilots. Landing is often considered the most difficult and critical part of flying. In the flanker, if the selected airfield is equipped with the Automatic Landing System (ALS), the autopilot can take care of most landing functions for you. If the airfield isn't equipped with the ALS system or your navigation equipment is damaged, you'll have to land the old fashioned way. To practice landings, see the landing training mission described in the Flight Training section.

▶ **Remember: The secret to all good landings is the approach!**

For information on locating an airbase, see the "Return Mode" in Chapter 4.

▶ **Move the stick as little and as smoothly as possible!**

Automatic Landing

To land the aircraft in automatic mode, engage the autopilot and switch to Return mode. The autopilot will fly the aircraft to the approach beacon and then switch to the Landing mode (ПОС). Then the autopilot will bring the aircraft down the ILS glide path right to the runway threshold. As soon as you fly over the runway threshold, the autopilot will change to bank stabilization mode in which it maintains zero bank angle and damps vertical speed. The autopilot disengages on the touchdown; 15 seconds after the bank stabilization mode is enable; or when the navigation system loses the ALS beam.

Keep very tight control of your airspeed! Don't forget to select timely deployment of the aircraft's mechanics (gear, flaps, and airbrake) and to brake to a full stop after touchdown. When close to the threshold you can resume manual control. Both fixed airbases and aircraft carriers are equipped with ALS systems.

Instrument Landing System

After you have reached the approach beacon the navigation system automatically switches to Landing mode, evidenced by the HUD switching from ВОЗВ to ПОС (LANDING) and the aircraft's Instrument Landing System (ILS) activating. The operating mode of the navigation system depends on the information being received from the landing systems of a chosen airfield. An airfield can have an automatic landing system and/or a glide path landing system. Depending on these circumstances, there are two methods of semiautomatic landing.

Many airfields are equipped with the Instrument Landing SystemSee ALS. The ILS generates the optimum approach trajectory (the glide path) with the help of two mutually perpendicular fan-shaped radio beams: Glideslope (horizontal) and Localizer (vertical). The range of the system is equal to about 25-30 km.

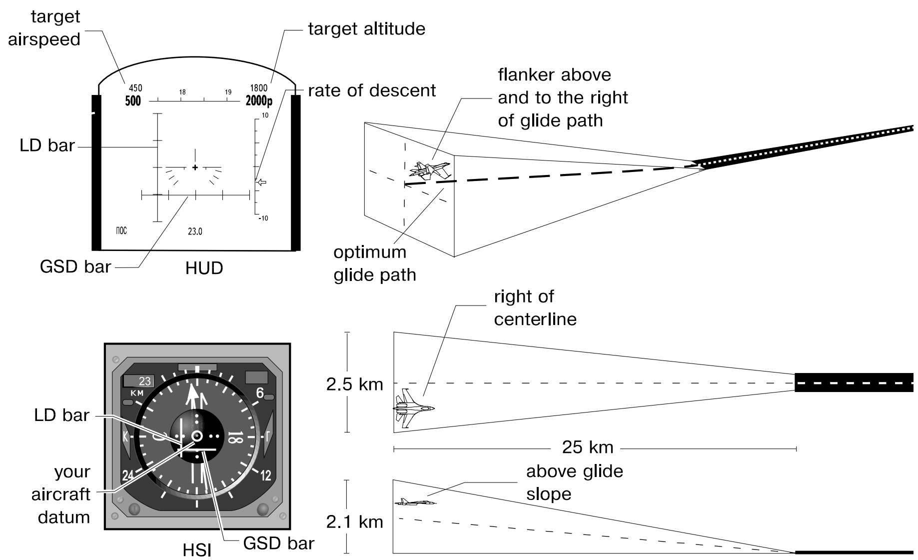


Figure 5-6: The ILS system.

In the figure, the aircraft is flying within the glide path cone, but slight to the right of the runway center line and a little above the desired glideslope. The ILS bars point the direction to the center of the runway. The LD bar is displayed along the left side of the HUD indicating the pilot needs to come left. The GS bar is below the center of the hud, showing the pilot needs to descend. In other words, fly toward the ILS bars.

During a semiautomatic landing, you can pilot the aircraft using the information displayed on the HUD, the HSI, and the ADI.

Get on the glide slope early on and hold the aircraft on the glide path. Use the ADI to assist your approach. It shows information on bank and pitch angles and mismatching heading and altitude. When landing, you should keep the required bank needle upright and the required pitch indicator at about the zero position.

▶ Hold the glide path, keep the intersection of the two ILS bars in the center of the HUD. Manoeuvre the aircraft gently and control your airspeed to match the required airspeed displayed.

The HUD also indicates the distance to the beacon. Note that the beacon is not situated at the runway threshold but at about 300 meters in. This is to ensure that the pilot won't land short. The vertical scale to the right indicates your rate of descent (or climb). The MFD shows a symbol of your aircraft connected with the airfield by a line. The airfield chosen for landing is enclosed in the square lock frame.

Figure 5-7: HUD symbology in Landing mode with the ALS

You should control airspeed and aircraft configuration as described in the section below.

Visual Approach

If an airfield does not have ILS or the aircraft is beyond the operating range of this system, you should guide the aircraft to the airfield using information on bearing to the radio beacon, distance to run and runway heading. In this mode the HUD displays the guidance reticle showing the deviation of your current heading from the required one, which coincides with the bearing to the radio beacon (see the figure below). Besides, the rate of descent scale to the right helps you control your vertical speed. At the bottom of the HUD the distance to the airfield radio beacon is displayed.

A visual approach and landing should be usually made according to the following procedure (see the figure below).

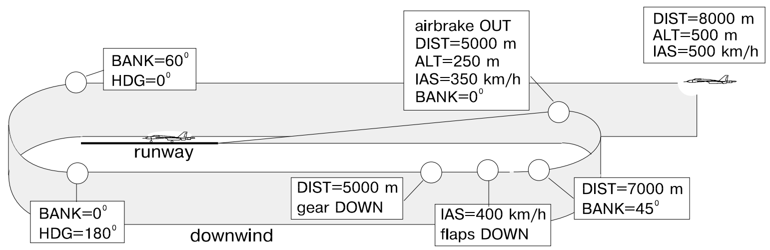


Figure 5-9: Visual approach landing pattern

Initial Approach

Starting about 10km from the runway, maintain an airspeed of 500 to 600 km /hr at an altitude of 500 to 600m. Align the aircraft with the runway. Arrive over the runway at an altitude of 300m and an airspeed of 450 to 500 km / hr. As you reach the middle of the runway, execute a 180° turn to the right (or left as desired) at a 60° to 80° bank angle. You'll now be heading parallel to the runway but on an opposite heading.

Continue this heading until about 5km from the runway threshold. Lower the landing gear and extend the speed brake. Decelerate to 400 km / hr, then lower the flaps. Execute the turn to the base leg (perpendicular to the runway) in the same direction as the last turn. As the runway approaches your wingtip, turn toward the runway, adjusting the turn rate as necessary to align with the runway center. Roll out when you're heading directly down the runway.

Final Approach

At about 5km from the runway, reduce speed to 350 km / hr at an altitude of 250 to 300 meters and proceed toward the runway. Ideally, cross the runway threshold at 270 to 280 km / hr at an altitude of 10 to 15 m. You can successfully land, however, after crossing the runway threshold as slow as 250 km/hr or as high as 50m. Smoothly flair the aircraft while keeping AOA at approximately 10 degrees with a sink rate (rate of descent) about 1 to 1.5 m/s. Sink rates higher than 3.8m/s risks damaging the landing gear on touchdown. If the aircraft sinks too fast, increase throttle immediately.

The aircraft should touch down at 220 to 250 km / hr. Deploy the drogue chute and cut the engines to idle. Apply the wheelbrakes. Maintain back pressure on the control stick to keep the nose up; this uses the aircraft's airframe as a giant speed brake. Stop or taxi as required.

Taxiing

If necessary, release the stick and wheel brakes, and taxi along the runway using the rudder pedals. Retract the air brake and flaps. Relax!

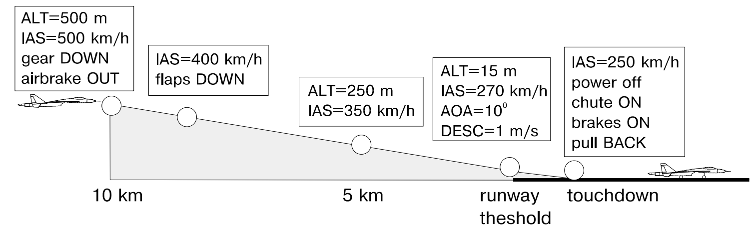


Figure 5-10: Final Approach

Carrier Landings

Carrier landings are the most demanding and dangerous task any nation asks its pilots to perform. The challenges of landing an aircraft moving 300km/hr on to a moving ship as it pitches and rolls with the seas requires incredible skill, concentration, and precision. The slightest mistake spells disaster, placing the aircraft, the aircrew, and the entire ship at risk.

To improve carrier landing success, we suggest you practice the carrier approach pattern at land-based airfield until you can nail the landing every time. Then, once you're confident you can appropriately control the aircraft, move on to carrier landings.

The carrier landing begins like any other landing. Select the BO3B navigation mode, fly to the approach point. As you near the initial approach fix, the navigation software automatically switches to the Landing mode. You may perform an automatic landing by engaging the autopilot with the A key.

Manual Approach

As with all landings, the key to carrier landings lies in the approach, smoothly following the ILS from the approach point down to the carrier's deck. It's very important to stay alert and detect any deviation from the flight path instantly. Flight path corrections must be immediate and aggressive, yet smooth; do not allow yourself to get "behind" the airplane (that is, let the airplane deviate too far from the desired flight path). Move the control stick with a graceful motion which flow from one position to the next. Poor stick control leads to over-corrections and pilot-induced oscillation (PIO). Above all else, trust your instruments. The ILS displayed on the HUD works the same for carrier landings as it does for field landings. The ILS will align you with the ship, indicate the required speed, and display the required altitude. Use the predictor bar on the ADI. These are very precise and will give you the exact degree of bank and pitch required for the perfect approach.

ВОЗВ navigation mode places your aircraft about 7 to 8km from the ship, flying at an altitude of approximately 700m and an airspeed of 350 to 400km/hr. Once in ПОС mode, lower the gear, drop the flaps, extend the hook, then turn to center the ILS course deviation bar on the HUD. Proceeding directly toward the carrier, extend the speed brake to help control airspeed. Follow the cues displayed on the HUD, keeping the ILS bars centered while maintaining the specified altitude and airspeed.

Figure 5-11a: 1km From the Ship

Continue following the ILS display until you're 1km from the ship. At this point, your airspeed should be down to between 290-310 km/hr, depending upon your gross weight, at an altitude of roughly 70 meters. Markings on the ship should be visible by now, giving you additional lineup cues. Make sure the Glide Path indexer on the left side of the HUD shows the green, center light. If your approach is too low the red light will illuminate. If your approach is too high, the yellow light will illuminate. If you are on the glide, the green light will illuminate. If you're more than 10 meters above or below the specified altitude, apply full power, retract the speed brake, and go around for another pass.

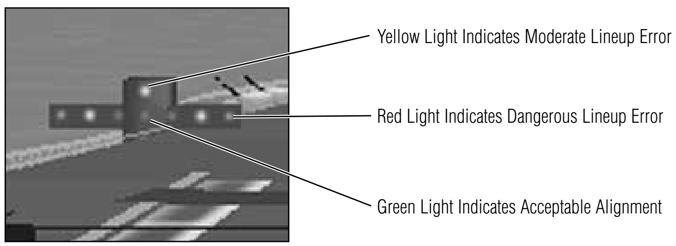


Figure 5-11b. The Meatball director lights

The final moments of the landing are fast and furious; you'll touch down at a speed of approximately 310 km/hr. Note the vertical velocity indicator along the right side of the HUD. At touch down, you should be descending about 6 m/s.

figure 5-11c: The final seconds of a carrier approach

With the appropriate approach path, the arresting hook should catch one of the arresting wires strung across the deck. Multiple wires are stretched across the landing surface to increase your chances of connecting with one. It may be difficult to tell if you've caught a wire or not; even upon successful arrestment the aircraft will continue forward several meters. As a precaution, increase throttle to full military (non-afterburner) thrust and retract the speed brake as soon as the wheels touch the deck. If the hook catches a cable, the aircraft will slow to a stop. If the hook misses all cables, the increased throttle ensures you have sufficient power to become airborne again.

Crosswind Landings

In a crosswind, the task becomes a little more difficult since it is necessary to consider the drift of the aircraft with respect to the runway heading. To land properly, it is required that the aircraft's velocity with respect to the ground should be parallel to the runway heading. This can be achieved in two ways.

To maintain translational movement in the direction of the ground speed vector (GS), the pilot should bank a little to the windward wing side while flying towards the runway and flare with a slight deflection of the stick in the direction of the wind. An increase in crosswind speed as well as decrease in the aircraft's true airspeed results in an increase in the slip angle required to compensate for drift. Intense crosswind may lead to maximum deflection of rudders and flaps, which could make landing impossible.

In the second case, the aircraft develops a heading lead angle and moves without sideslip with respect to the runway. Hence, there is no need in controlling the position of the rudder and flaps while closing in to the runway. Right before the touchdown or on the touchdown, line up the aircraft with the runway. As opposed to the first method, this method makes it possible to land at higher crosswind speeds, yet is more complicated in the piloting technique.

Single Engine Landings

Single engine landings are inherently dangerous. You're low, slow, and lack the power to climb away if something goes wrong. You have to fly the correct approach the entire way. A single mistake is often fatal.

Like all landings, success or failure depends on the approach. Using the Return (ВОЗВ) HUD mode, intercept the initial approach point at 1,000m altitude and 450 km/hr airspeed. Since your ability to climb is severely limited, fly a little high throughout the entire glidepath and keep your speed up. Generally, keep your speed and altitude 10% to 20% higher than normal. If you slow down or drop below the glidepath, you probably don't have enough thrust to recover. This means you'll land "long," or farther than normal down the runway, but that's better than crashing in the grass short of the threshold.

▶ **If the aircraft stalls or airspeed falls well below the glideslope, eject immediately! Ctrl+E 3 times!**

Stalls and Spins

As explained earlier, a stall occurs when AOA increases to the point of disrupting airflow over the wing. This situation will not cease until AOA is reduced. If significant yaw is present during the stall, a departure from controlled flight called a spin may occur. Pilots pushing their aircraft to the edge of the performance envelope must always endeavor to avoid these conditions since they effectively take the pilot out of combat until recovery is completed.

▶ **When passing through 1,500m in an out-of-control situation, eject!**

The flight control system will normally limit the aircraft to 27.5 degrees AOA, with stall AOA occurring at 33 degrees. Under normal circumstances, this should keep the aircraft out of trouble; however, there are ways to defeat the system. First, the pilot can override the AOA limiter either by disabling the system or applying an extra 15kg of force to the stick and "pulling through" the limiter. Also, rudder is generally used to assist turns, especially at low airspeed. However, keep in mind:

1. An intensive rotation in the lateral and directional channels produces a destabilizing pitch moment which may cause an increase in AOA beyond the permissible limit.
2. High slip angles develop at an AOA approaching the maximum operational value may lead to an earlier stall.
3. Deflecting the stick in the roll channel at AOAs approaching the maximum operational value may result in the reverse action (you move the stick left but the aircraft banks right) and possibly an earlier stall.

Stall Recognition and Recovery

At high AOA, the aircraft will start to buffet in the pitch axis, with the intensity increasing at extreme AOA due to the disruption of airflow over the wing. This buffeting provides an indication of how close you are to stall AOA. Light buffet indicates you are near the edge of the envelope and probably achieving maximum turn performance.

When an aircraft stalls, lift is greatly reduced. As explained above, turn performance depends greatly on g-load. Consequently, a stalled aircraft generally stops turning. Momentum causes the aircraft to move in a straight line tangent to the original turn circle. This can be disastrous in a dogfight or when attempting to evade an incoming missile. Buffet, therefore, is the "warning" that you're pushing the edge of the envelope and are risking a stall.

In flying at high AOA and low speeds, be very careful and very gentle with the stick inputs. Even the slightest pitch increase could result in a stall. Be very smooth with the stick inputs. If buffet increases in intensity, reduce back pressure on the stick.

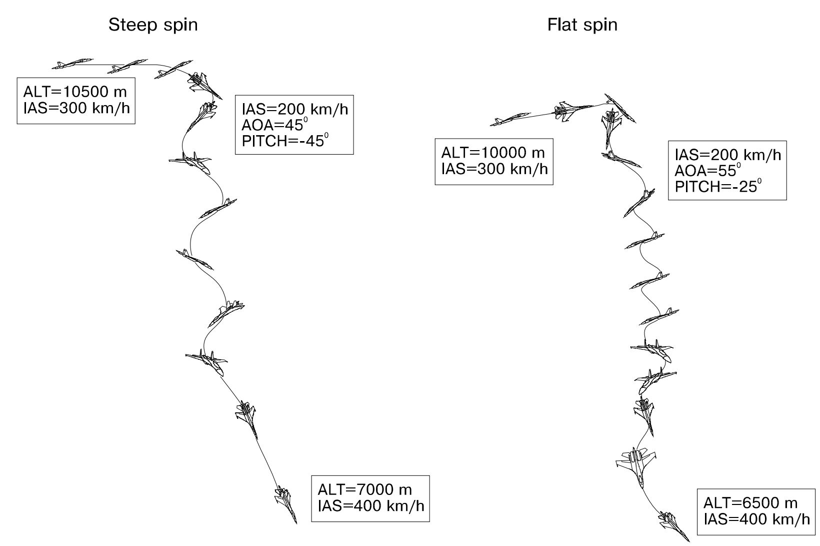
For speed less than 350 km/hr, the AOA limiter will attempt to keep the Su-27 below 27.5 degrees, and the Su-33 below 30 degrees AOA. Above 350 km/hr, the AOA limiter attempts to keep both aircraft below 27.5 degrees AOA. These limits can be defeated, though. The limiter can be disabled using the K key, the pilot can exceed the limits by applying more aft stick when the limit is reached, and (in some cases) the AOA limiter may not be able to adequately control the AOA value. Nose-high, low-speed conditions are especially dangerous.

Spin Recognition and Recovery

If the nose yaws during a stall a spin may develop. Depending on the pitch angle at the time of entry, a spin can be steep or flat. An aircraft in a steep spin rotates with a yaw rate of roughly 110 degrees per second, holds an AOA of roughly 40 to 45 degrees, and pitches down about –30 to –40 degrees below the horizon. A flat spin is characterized by a high yaw rate of 110 to 140 degrees per second with an AOA in excess of 45 degrees and pitches down about 10-20 degrees below the horizon.

To recover from a spin:

1) Ensure that power is back to flight idle
2) Centralize the stick.
3) Apply opposite rudder (If the slip ball is right then you are spinning left, so step on the right rudder. Ball right, step on right rudder).
4) As the rotation slows to zero, centralize the rudder and apply gentle forward pressure to the stick until the AOA is normal.
5) Add power and accelerate from critical airspeeds and angles.



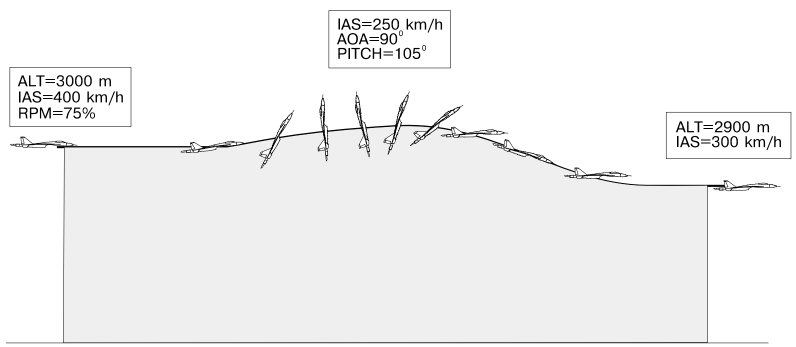
Typical Steep and Flat Spin Profiles

Aerobatics

A testament to the quality of its design, the Su-27 and subsequent variants have substantial aerobatic capabilities. While the combat effectiveness of some of the more exotic manoeuvres remains a topic of debate, such performances are crowd favorites at airshows around the world.

Pugachev's Cobra

Pugachev's Cobra or dynamic braking is a manoeuvre in which within 3-4 seconds the nose of the aircraft is pulled up to high angles of attack (80-110°) and then returned to normal horizontal flight. This causes intensive loss of airspeed. You can execute this manoeuvre from level flight at various altitudes and at indicated airspeeds of 350-450 km/h. The figure below illustrates a typical Cobra manoeuvre:

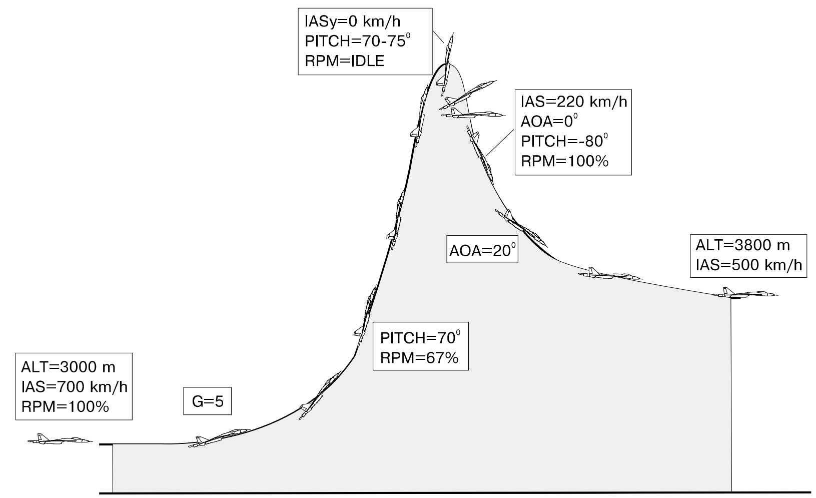


Cobra Manoeuvre

In level flight at the appropriate entry speed of 350 to 450 km/h, disable the AOA limiter by pressing the K key. Execute the cobra by pulling the stick fully aft. As the nose reaches the vertical (pointed straight up) allow the stick to go to neutral and let the nose fall back down to level flight. Smoothly increase thrust towards the end of the manoeuvre. The AOA limiter will automatically re-engage after executing the cobra.

Tailslide

A tail slide (also known as the "bell" in Russian) is a zoom manoeuvre executed at a high pitch angle (70-75°). It results in a drop of vertical speed to zero though the horizontal airspeed remains above zero at 10-20 km/h. Then the aircraft will slide downwards for up to 100 m and then executes a turn in pitch with a recovery to level flight. A typical tail slide may be executed starting at different altitudes and at airspeeds of 500-800 km/h.



The tailslide

This manoeuvre is demonstrated by the Flanker at air shows and is arguably considered of little combat value. However, the experts assert that when an aircraft slows down at the top of the tail slide, it effectively "beams" all modern enemy radar systems (at the expense of all its airspeed). Along with the famous Cobra manoeuvre, the tail slide dramatically demonstrates the Flanker's staggering capability to remain stable at high angles of attack and low airspeeds and definitely shows superb engine design.

A typical tail slide is shown on the diagram below:

1. Start a climb to the near vertical (70° pitch angle).
2. Once established on a stable 70 degree nose up trajectory, reduce power to idle and maintain the 70 degree angle. Extra care should be exercised if the pitch angles go beyond 75, as excessive pulling back on the stick may result in an overshoot in pitch beyond the vertical and potential deceleration into high negative AOAs.
3. After the aircraft has begun to fall (develops negative vertical velocity), bring the stick smoothly back.
4. The aircraft will fall forward and nose down. Compensate for any tendency to spin right with the left rudder (the Z key). This tendency right is due to the gyroscopic effect generated by the engines. In the real aircraft you would also use some right engine input to compensate for this effect, but unfortunately only a few of you will have split throttles connected to your PC.
5. Bring the power up to 100% and let the aircraft accelerate to approximately 500 km/h, then level off normally.

FLIGHT TRAINING

Now that you understand the concepts behind air combat, it's time to see them in practice. In the next chapter, we've developed a series of training missions designed to talk you through basic flight manoeuvres while our instructor pilot talks you through them.


Defense Visual Information Center - Department of Defense

CHAPTER 6
Weapons

INTRODUCTION TO FLANKER WEAPONS

From somewhat modest beginnings in WWI, airpower quickly gained acceptance and thoroughly changed the nature of combat. While ground troops are required to take and hold territory, support from the air (whether releasing weapons, delivering supplies, or deploying forward troops) has become instrumental in every major military's operational doctrine. Obtaining air superiority and denying the enemy usage of his aircraft has become one of their prime objectives. With the ability to cover hundreds of miles in only a few hours, aircraft have also changed the nature of power projection. A floating runway called an aircraft carrier can have aircraft on station mere hours after an outbreak of trouble! Air power assumes many roles on the modern battlefield, and the Flanker family is well-designed to accomplish those roles. The Su-27's primary mission is air superiority; the Su-33 multi-role fighter handles both air-to-air and air-to-ground tasks admirably.

In any case, the ultimate role of a fighter aircraft is to deliver weapons on target and return safely. In this chapter we'll teach you how to do exactly that. Here we'll examine the capabilities of the weapons on hand and how to best employ them.

AIR-TO-AIR WEAPONS

The Flanker carries a mixture of radar-guided air-to-air missiles, heat-seeking air-to-air missiles, and 30mm cannon, giving it the ability to engage airborne targets under a wide variety of circumstances. Each weapon type has strength and weaknesses along with performance nuances. Successful air-to-air combat depends on a thorough understanding of the weapons and their limitations.

The GSh-301 Cannon

The gun is the most basic of air combat weapons. Although many believed the advent of air-to-air guided missiles would make the gun obsolete, repeated experience has shown that the gun remains an integral part of an aircraft's weapons package. The Flanker carries 150 rounds of 30mm ammunition capable of inflicting serious damage on an enemy aircraft. Activate the cannon mode by pressing the C key from any air-to-air mode or while in air-to-ground mode.

Using Radar or Electro-Optical System (EOS) Targeting

Fortunately, the radar and EOS simplify the task of aerial gunnery by accurately measuring the range to the target and providing helpful cues on the HUD. Locking a target in Close Air Combat or Helmet Mounted Sight modes greatly improves the chances of hitting the target.

Once the target has been locked, extra cues appear on the HUD. The left side of the HUD shows the "Autotrack" cue (indicating the system is operational and tracking a target) along with a vertical range bar. The range bar provides three types of information at once:

1. Range to target – The arrow symbol along the right side of the range bar indicates how far away the target is. The marks along the left side of the bar help estimate the distance.
2. Effective cannon range – The marks along the right side of the bar indicate the cannon's maximum and minimum firing ranges.
3. Aspect angle - The pointed arrow affixed to the bottom of the range bar shows the target's heading relative to yours. If the arrow points straight up, you're directly behind the target. If the arrow points straight down, the target is heading directly at you.

6-3: The Autotrack HUD Symbology (Range > 1400 meters)

As usual when locking a target, the target's airspeed and altitude are displayed above your own. The number of cannon rounds remaining is displayed in the lower right corner of the HUD. The aiming reticle is superimposed over the target as long as you maintain the lock.

► **In general, steer your aircraft to keep the aiming reticle near the center of the HUD; this prevents the target from breaking the lock with a sudden manoeuvre.**

As you close inside 1,400 meters, the symbology changes. The range bar disappears and aiming crosshairs, also called the "pipper", appear. The circle around the aiming crosshairs now represents the range to the target; the arc of the circle recedes counterclockwise as you get closer. The smaller the arc, the closer you are to the target. A full circle indicates the target is 1400 meters away.

To shoot the target, manoeuvre the pipper over the aiming reticle. When the computer calculates that you're in range, the shoot cue will appear. If you approach the target too close, the HUD may show the Reject Cue OTB.

If the target manages to break the tracking lock, the HUD switches to the standard gun funnel mode. To re-establish the lock, disable the cannon by pressing C and repeat the target lock sequence using either the radar.

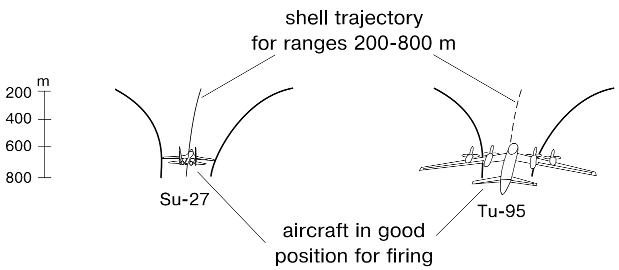
Using the Cannon Funnel

In the event that the radar and EOS are unavailable or your are unable to achieve a lock, you can use the funnel display to manually aim the guns. The funnel appears whenever you enable the cannon (by pressing **C**) without having first acquired a lock. The funnel is designed to indicate the required amount of lead angle when firing at a fighter-sized target 200m to 800m away.

The funnel consists of two curved lines. The distance between the two lines represents a width of 15m (the approximate wingspan of many fighter-sized targets) at varying ranges from 200m (top of the funnel) to 800m (bottom of the funnel). To use the funnel, bank your aircraft until the horizontal line in the middle is parallel to the target's wings (indicating you are in the same plane of manoeuvre as the target). Pull lead until the wingtips of the target just touch the two outer edges of the funnel. The further away the target is, the smaller its wingspan appears, so the further down the funnel you place it, thereby increasing the amount of lead you're pulling. Rounds fired now will impact the target.

6-5: The Gunnery Funnel

What happens if the target's wingspan is greater than (or less than) 15m? The funnel specifically represents a wingspan of 15m; against larger or smaller targets you'll have to estimate the difference. For example, a large target like a Tu-95 has a wingspan of roughly 50m and will overlap the funnel. Figure 6-6 illustrates, comparing an Su-27 and a Tu-95 700m away:



6-6: Comparing Target Wingspans with the Targeting Funnel

The following table shows the wingspans (minimum and maximum for variable-geometry aircraft) that you're likely to encounter. When engaging a target smaller or larger than 15m, remember to adjust the funnel accordingly. If the target is smaller, don't pull as much lead. If the target is larger, pull more lead than indicated by the funnel.

AIRCRAFT	WINGSPAN, M	AIRCRAFT	WINGSPAN, M
MiG-23	7.8/14	Tu-22	23.6
MiG-27	7.8/14	Tu-95	50.05
MiG-29	11.36	Tu-142	51.1
MiG-31	13.46	Il-76	50.3
Su-24	10.36/17.63	A-50	50.3
Su-25	14.36	F-15	13.1
Su-27	14.72	F-16	9.4

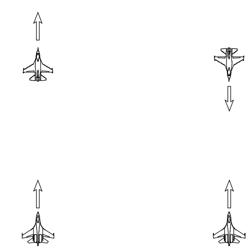
Air-to-Air Missiles

Missiles:Air-to-air;Missiles are not "magic bullets" by any stretch of the imagination. Like aircraft, they must obey the laws of physics and have very specific flight envelopes. When fired within the appropriate parameters, missiles have a deadly performance advantage over aircraft. When fired in marginal situations, however, the missile's chances of success goes down dramatically.

Kinematic Range Against Non-Manoeuvreing Targets

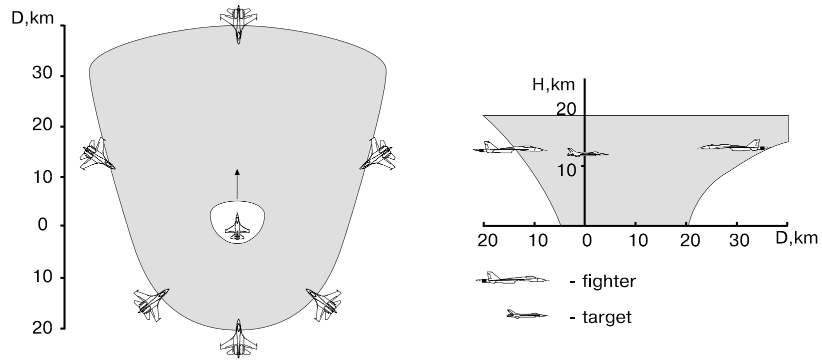
Like aircraft, a missile's biggest problem is thrust. Missiles have a very limited amount of space for onboard fuel. Consequently, a missile's engine burns for a very short time (just a few seconds in some cases) and quickly accelerates the missile to maximum speed. The motor then burns out and the missile relies on its rapidly decaying momentum to reach the target. As with aircraft, the missile's turn performance is dependent upon how many g's it can pull. The slower the missile is, the less g's it can pull. The maximum range at which the missile is effective against a non-manoeuvreing target is called its kinematic range. As we'll see later, however, "range" is a very elusive topic.

Target aspect angle has a large impact on the missile's effective range. As shown in figure 6-7, a target heading directly at the missile covers part of the range. The shooter can fire the missile earlier since the target flies toward the missile, shortening the missile's time of flight. Conversely, a tail aspect greatly reduces missile range since the target is running away from the missile. Suppose the missile is fired at a target 10km away. It takes the missile several seconds to travel that distance. By the time the missile has flown 10km, the target may have moved another one or two kilometers further away. Missiles are substantially faster than aircraft, but run out of fuel much faster as well.



6-7: Effects of Head and Tail Aspect Angles on Missile Kinematic Range

The left-hand illustration in figure 6-8 shows a typical envelope for a missile fired at a non-manoeuvreing target (in the center of the diagram). The grey zone represents the ranges from which the missile may be fired based on aspect angle. Notice that when fired head-on, the range is significantly longer than when fired from behind. The white area around target defines the minimum range requirements for the missile. Since directly hitting the target is unlikely, most missile warheads are designed to emit some form of shrapnel in order to damage nearby aircraft. To prevent the launching aircraft from inadvertently being damaged by the missile explosion, the missile does not arm until it has flown a safe distance from the shooter. Also, the missile seeker or guidance system may require some amount of time to engage the target. The distance the missile must fly is known as the minimum range.



6-8: A Typical Missile Envelope Against a Co-altitude, Non-manoeuvreing Target

Notice the right-hand illustration in figure 6-8. This shows the second major factor in missile range: altitude. Generally speaking, a missile's kinematic range doubles for each 6,100m (20,000 feet) that altitude is increased. For example, if the missile's kinematic range is 20km at sea level, it will double to approximately 40km when fired at a co-altitude target 6,100m higher. At 12,200m (approximately 40,000 feet), missile range would increase to 80km. When fired at a higher or lower target, the missile's range is generally associated with the median altitude between the shooter and the target (assuming the missile can climb high enough when fired at a higher altitude target).

Finally, the speed of the launching aircraft greatly impacts missile kinematic range. The slower the launcher is moving, the longer the missile will take to reach maximum speed. More of its limited motor burn will be spent accelerating to cruise speed. If the missile is launched at a higher speed, it will reach cruise speed and altitude faster, saving more of the motor burn for the "cruise" portion of the flight. Likewise, the speed of the target impacts the missile range as well. The faster the target is moving, the more distance it will cover during the missile's time of flight. In a tail-chase scenario, the target may escape the missile's maximum range. In a head-on scenario, the target may close inside the missile's minimum range!

Manoeuvreing Targets and Missile Evasion

Unfortunately, target aircraft rarely cooperate with your plans and often attempt to evade your missiles. So far, we have not discussed how target manoeuvreing affects missile performance. When fired at a manoeuvreing target, the missile will follow a curved trajectory to the target. This increases drag, bleeds speed, and reduces the missile's effective range.

The target may attempt to "drag" the missile; in this case the target executes a high-g turn until it facing directly away from the missile, then unload to 1g and accelerate directly away from the incoming missile. In this case, the target is attempting to place the missile in the shorter "tail aspect" portion of its flight envelope. Success depends primarily on how quickly the target can turn (a light fighter may execute an 8g or 9g turn, a heavily laden attack aircraft may be limited to 5g or 6g) and how quickly it can accelerate after bleeding speed away in that turn. Modern, more-capable missiles may have a no-escape zone; that is, at a given range (say 10km), no

aircraft in the world can turn fast enough and accelerate fast enough to escape. That same missile, though, may be unable to catch an aircraft performing a 6.5g drag turn 25km away.

The target may also attempt to "beam" the missile by turning toward the missile to place the inbound missile at either the 3 o'clock or 9 o'clock position, then maintaining a sufficient turn to keep the missile there. This forces the missile to execute a continuous turn, bleeding speed and energy all the while. The target may also turn away to place the missile at the beam position as well. In any event, the target is trying to make the missile expend as much energy as possible, which shortens its range and its manoeuvreability.

Conclusion

From this we see that "missile range" is a very complex topic. Merely knowing that a missile has a 30km range doesn't do much good… when fired from what altitude? When the target is at what altitude? Against what aspect angle? At what airspeed? Overall, we can draw two main conclusions:

1. The closer you are to the target when you shoot, the better the chances that your missile will hit the target. Missiles fired at or near their maximum range (for the given circumstances) are not very likely to hit.
2. Launching from higher airspeed and altitudes significantly increases the missile's effective range.

Missile Guidance

The missile's guidance systems provide inputs to the missile's control system, which in turn manoeuvres the missile to intercept the target. Most modern AAMs are based on homing guidance. When homing, the guidance law is formed in the missile's computer using information on target motion. There are three types of homing: passive, semi-active, and active.

The simplest of these types, passive homing relies on emissions given off by the target itself (radio, heat, light, sound). In case of active and semi-active homing, the target is illuminated (usually by radar or laser), and the homing system guides on the illumination energy reflected off the target. For active homing guidance the missile itself illuminates and tracks the target. Semi-active homing implies that some source external to the missile (for example, the radar of the launching platform) illuminates the target.

Some missiles, especially long range ones, use combined guidance: inertial radio-corrected guidance and homing on the terminal part of flight. To implement inertial guidance, the launching aircraft computer feeds into the missile's control system information on target coordinates, trajectory and relative speed.

After the missile has started, its guidance system uses the information about the relative position of the missile and the interception point computed by the navigation system. During the flight of the missile, the interception point may significantly change. For this reason, radio correction supplements the inertial guidance. This increases the accuracy with which the missile reaches the target area. Upon approaching to the target, the guidance system switches to homing, passive or active.

To home, a missile needs a device that will receive radiation from a target (sense it) and track the target. This device, known as a seeker, is located in the nose of the missile. However, semi-active homers may include a rear receiver for reception of information from the illuminating platform. Active homers contain a transmitter and receiver generally located forward. Depending on the type of radiation received by the missile, the seeker may be of infrared or radar type.

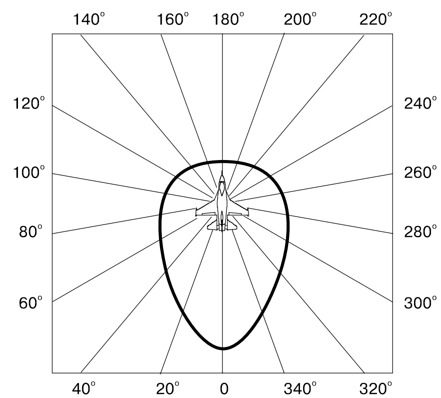
Passive Homing

Most seekers with passive homing are infrared (IR) seekers reacting to heat-radiating objects. This device contains a material sensitive to heat (IR radiation) that is produced primarily by the target's propulsion system. The detector is often cryogenically cooled to eliminate internally generated temperature and allow detection of even very small amounts of IR energy coming from an external source.

▶ Passive seekers have an inherent advantage in their maximum range because their received power is inversely proportional to the square of the target range. The maximum range of active and semi-active systems varies inversely with the fourth power of the transmitter strength.

The range at which an IR seeker can see a target depends on the intensity of IR-radiation emitted by the target in the direction of the sensor and the seeker sensitivity. Therefore, the track range of the IR seeker depends very much on the engine operating mode of the aircraft being tracked and on the aspect angle, reaching its maximum value for attacks in the rear quarter.

The figure below presents a diagram of the IR-radiation intensity by a single-engined aircraft in the horizontal plane.



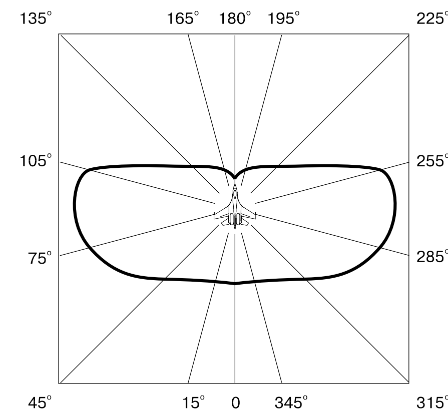
6-9: IR Radiation Intensity

After the launch, a missile using passive homing becomes completely autonomous and is known as "fire-and-forget". If an IR seeker provides tracking of a target at any aspect angle, the seeker is said to be all-aspect, otherwise it is a rear-aspect seeker.

One of the major drawbacks of passive homing is its dependence on a "cooperative" target that continues to emit the energy required for homing. Besides, IR energy is absorbed and dissipated by water vapor, making heat seekers all but useless in clouds or rain. Discrimination between the target and background radiation generated by the sun, reflections off water, snow, clouds and hot terrain such as deserts can also be a problem for IR seekers.

Semi-active and Active Homing

For semi-active and active homing, a missile uses a radar seeker head. Radar-guided missiles are currently the most widely used all-weather AAMs. Here the power of radio emission from a target and the sensitivity of the receiver determine the missile's ability to track the target. As this case involves reflected radiation, its intensity depends on the power of the illuminating source and on the target's ability to reflect radio waves; i.e., it's radar cross section (RCS). This ability significantly depends on the aspect angle of the target. Besides aspect angle, the reflection of radio waves depends on the size, shape and details of construction of the target. The figure below shows a typical diagram of reflected signal intensity:



6-10: Radar Cross Section Illustrated

Although semi-active homing provides acquisition of uncooperative targets and is good for long distances, one of its major problems is greatly increased complexity which results in reduced reliability. Essentially this technique requires two separate tracking systems to be successful (one in the missile, the other in the guidance platform). Another serious drawback is the requirement for target illumination by the guidance platform throughout the missile's flight. This requirement makes the illuminator vulnerable to passive-homing weapons, and with airborne illuminators it often restricts the manoeuvreing option of the aircraft providing target illumination.

Although active homing requires a more complex, larger and more expensive missile, the total guidance system is no more involved than that of the semi-active system, and in some ways it is simpler and more reliable. It also gives the launching platform "fire-and-forget" capability, as do passive systems. One disadvantage, however, is the possibility of reduced target detection and tracking ranges. Since the range of target acquisition is proportional to the area of the illuminating

antenna, all other factors being equal, the tracking range of the aircraft radar greatly surpasses that of the missile. Therefore, semi-active homing is possible at considerably greater distances than active homing. That is why active homing is frequently used in a combination with inertial guidance or semi-active homing and sometimes passive homing.

Target Tracking

A variety of guidance laws are implemented in modern AAMs. Most missiles that employ proportional navigation techniques require a moveable seeker to keep track of the target. Such seekers have physical stops in all directions, called gimbal limits, which restrict their field of vision and therefore limit the amount of lead the missile may develop. If the seeker hits the gimbal limit, the missile usually loses its guidance capability, i.e. "goes ballistic". Such a situation most often develops when the line of sight to the target moves fast and the missile's speed advantage over the target is low.

Using onboard systems, the pilot searches, detects and acquires a target, then feeds the targeting data into the selected weapon. The missile can be launched if the current targeting data fit the characteristics of the guidance system of the chosen type of missiles. (For example, the aspect angle to the target falls within the gimbal limits of the seeker, and the intensity of radiation from the target is within the sensitivity limits of the seeker).

The pilot can launch the missile when it falls within the limits of the possible launch zone, which is usually calculated by the aircraft's onboard computer. The computer displays on the HUD information about the maximum and minimum range of launch and lights the ПР– shoot cue (Russian designation for Launch Allowed, pronounced 'pe-er') when the missile is ready.

Target Destruction

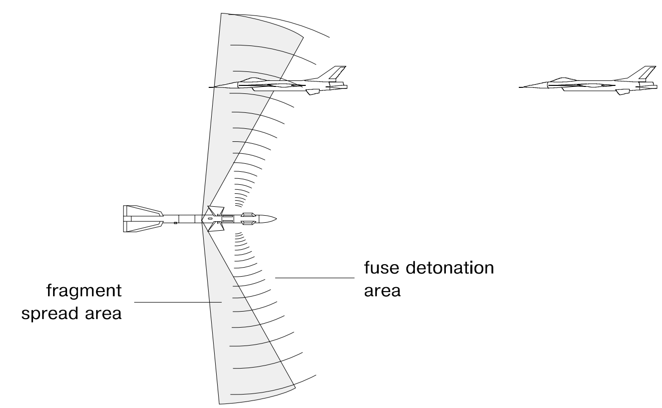
The warheads used in AAMs are typically blast-fragmentation, creating a cloud of incendiary/explosive pellets or an expanding metal rod. Blast fragmentation warheads cause damage through the combined effects of the explosive shock wave and high-velocity fragments (usually pieces of the warhead casing). Pellet designs are similar, except some of the fragments are actually small bomblets that explode or burn on contact with, or penetration of, the target. The damage to airborne targets from blast effect alone is not usually great unless the missile actually hits the target. Fragments tend to spread out from the point of the explosion, rapidly losing killing power as miss distance increases. Pellets reduce this problem somewhat since a single hit can do more damage. The expanding-rod warheads have metal rods densely packed on the lateral surface of an explosive charge in one or several layers. The ends of these rods are welded in pairs so that while spreading after the explosion of the charge they form a solid extending spiral-shaped ring.

The lethality of a warhead depends largely on the amount of explosive material and the number and size of the fragments. Larger expected miss distances and imprecise fuses require bigger warheads. The greater the weight of the warhead, the more effectively it destroys the target. However, the larger the warhead the greater the overall weight of the missile and hence the less manoeuvreable it is.

The purpose of a missile fuse system is to cause the detonation of the warhead at the time that produces the maximum target damage. Fuses can be classified as contact, time delay, command, and proximity. Contact fuses are activated upon contact with the target. This type of fuze is often used in combination with another type. Time-delay fuses are pre-set before launch to explode at a given time that is calculated to place the missile in the vicinity of the target. Command fuses are activated by radio commands from the guidance platform when the tracking system indicates that the missile has reached its closest point to the target.

Modern AAMs mostly use proximity fuses which are probably the most effective against manoeuvreing targets. They come in many designs including active, semi-active, and passive. An active fuze sends out some sort of signal and activates when it receives a reflection from the target. Semi-active fuses generally function on an interaction between the guidance system and the target. Passive fuses rely for their activation on a phenomenon associated with the target. This might be noise, heat, radio emissions, etc.

Proximity fuses are usually tailored to the guidance trajectory of the missile, the most probable target, and the most likely intercept geometry. They determine the closure rate, bearing, distance to the target, and other parameters. This ensures high combat efficiency of the warhead by rationally matching a fuze detonation area and a fragment spread area generally forming a cone-shaped lethal volume ahead of the warhead detonation point.



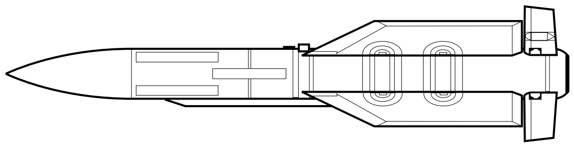
6-11: Fuze Detonation Patterns

Note that modern AAMs contain a self-destruct mechanism in case the missile loses lock or control.

The pilot selects a particular type of missile depending on distance to the target and its manoeuvreability. Considering these characteristics, AA missiles can be divided into long-range, medium-range, and close air combat missiles.

Long Range Missiles

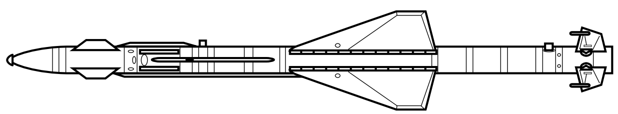
R-33E / AA-9 Amos



The R-33E (USA/NATO designation: AA-9/'Amos') designed by the Vympel OKB is a long range guided missile with an operating range up to 160 km. The missile employs inertial control and semi-active radar guidance on the terminal segment of flight. The R-33E is used to intercept aircraft and cruise missiles, that is why it is the principal missile of the MiG-31 Foxhound. The missile is capable of destroying targets ranging in altitude from 25 m to 28 km and flying at speeds up to Mach 3.5. Relative difference in altitudes of the missile and the target can be up to 10 km. The R-33E flies at Mach 4.5.

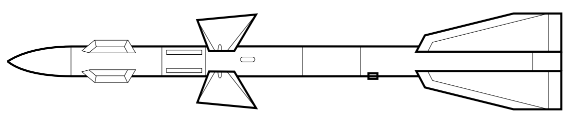
Medium Range Missiles

R-23 / AA-7 Apex



The Vympel R-23 (AA-7 'Apex') medium-range missile comes in two modifications with different seeker types. The R-23R ('AA-7A') has a semi-active radar seeker while the R-23T ('AA-7B') has an IR seeker. Both the missiles have a maximum range of about 25-35 km. An older missile, the R-23 is often replaced by the more powerful and intelligent R-27 'Alamo'.

R-27 / AA-10 Alamo



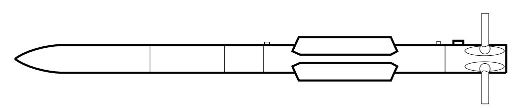
AA-10 Alamo (See Also AA-10; R-27;The Vympel R-27 (AA-10 'Alamo') is the primary medium-range AAM for the Su-27 and is available in several variants. The R-27 entered production in 1982 specifically for use on the new MiG-29 and Su-27 in place of the R-23 'Apex' used by the MiG-23.

The R-27 is effective against highly manoeuvreable aircraft, helicopters, and cruise missiles. It can destroy targets at any aspect angle, both in daylight and at night, in good or bad weather. Its guidance system is resistant to natural interference and ECM, and capable of tracking targets against ground and water clutter. The R-27 can engage targets ranging in altitude from 25 m to 20 km with elevation up to 10 km. The targets can fly at speeds up to 3500 km/h and with g-load up to 8 Gs.

The R-27 has a large number of versions equipped with various seeker heads. The basic semi-active radar homing (SARH) version is the R-27R ('Alamo-A'), often carried in conjunction with an R-27T ('Alamo-B') IR-homing missile so that pairs of SARH and IR-homing missiles can be "ripple-fired" for improved kill probability. Long-range versions of both missiles have a new boost sustain motor and are externally recognizable by their increased body length and a slightly "fattened" rear fuselage. These are designated R-27Re and R-27TE respectively. Two other variants are the R-27EM with an improved SARH seeker for better performance against low-flying and sea-skimming missiles, and the R-27AE with active radar terminal homing. The Su-27 standard warload includes six R-27s.

VERSION	RUSSIAN	GUIDANCE	MAXIMUM RANGE AT HIGH ALTITUDE/LOW ALTITUDE, KM
R-27R	Р-27	Inertial radio-corrected guidance and semi-active radar terminal homing	80/10
R-27T	Р-27	All-aspect passive infrared homing	72/10
R-27RE	Р-27Э	The same as in R-27R	170/30
R-27TE	Р-27Э	The same as in R-27T	120/15
R-27EM	Р-27ИМ	Inertial radio-corrected guidance and semi-active radar terminal homing (able to destroy cruise missiles at a height of 3 m above water surface)	120/20
R-27AE	Р-27АИ	Inertial radio-corrected guidance and active radar terminal homing	120/20

R-77 / AA-12 Adder

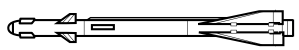


The Vympel R-77 (AA-12 'Adder') is a new-generation medium-range AAM. This missile is unofficially dubbed "AMRAAMski" in the West. The R-77 entered limited production in 1992 and is primarily intended for the new advanced versions of the Su-27 and MiG-29. The missile employs radio command guidance on the initial part of flight and active radar homing on approach to the target (15 km and less).

The R-77 can be effectively used against highly manoeuvreable aircraft, cruise missiles, AAMs and SAMs, strategic bombers, helicopters (including helicopters in hover mode). It can destroy targets moving in any direction and at any aspect angle, in daytime and at night, in good or bad weather. Its guidance system is resistant to ECM and is capable of tracking targets against ground and water clutter. Maximum operating range is 90 km. The missile can attack targets at aspect angles up to 90°. The R-77 has a maximum speed at high altitude of Mach 4.0.

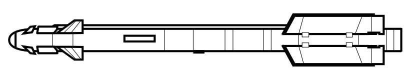
Close Air Combat Missiles

R-60 / AA-8 Aphid



The R-60 (AA-8 'Aphid') missile is a close air combat missile with all-aspect infrared passive homing. The maximum operating range is 10 km. The missile normally flies at Mach 2. The R-60 can be carried practically by any Russian combat aircraft and by many helicopters, though it is now considered obsolete and often replaced by the more intelligent R-73.

R-73 / AA-11 Archer



The Vympel R-73 (AA-11 'Archer') was developed as a replacement for the R-60 and is the first of a new generation of highly manoeuvreable missiles for close air combat. The missile employs IR passive homing and has been described as being "a decade ahead of current Sidewinder" variants, and as the most sophisticated IR-guided AAM in service. The R-73 has a new level of agility and is capable of off-axis launch from all aspects. It has a very wide-angle sensor which can be slaved to the pilot's helmet-mounted sight, allowing the missile to be locked up at targets up to 60° from the aircraft axis. The missile can be launched from aircraft pulling up to 8.5 Gs.

The R-73 employs aerodynamic control combined with vectored thrust. Tremendous manoeuvreability (up to 12 Gs) is conferred by the missile's combination of forward-mounted canard fins, rudderons on the fixed tailfins, and deflector vanes in the rocket nozzle.

The missile has a 7.4-kg expanding rod warhead and can destroy targets at altitudes of as low as 5 meters and at ranges up to 30 km. The R-73 normally flies at Mach 2.5.

The table below contains the comparative characteristics of various types of modern Russian AAMs. The maximum number of a specific type of weapon that can be carried is shown next to the aircraft designation in parentheses.

TYPE	RUSSIAN	USA/NATO	CARRIER (#)	WEIGHT, KG	SEEKER	RANGE, KM (MAXIMUM RANGE AT HIGH ALTITUDE)
R-23R	Р-23Р	AA-7A/Apex	MiG-23 (2)	223	SARH	35/25
R-23T	Р-23Т	AA-7B/ Apex	MiG-23 (2)	217	IR	35/25
R-27R	Р-27Р	AA-10A/Alamo-A	MiG-29 (4), Su-27 (6), Su-33	253	SARH	80
R-27T	Р-27Т	AA-10B/Alamo-B	MiG-29 (4), Su-27 (6), Su-33	254	IR	72
R-27RE	Р-27РЭ	AA-10C/Alamo-C	MiG-29 (4), Su-27 (6), Su-33	350	SARH	170
R-27TE	Р-27ТЭ	AA-10D/Alamo-D	MiG-29 (4), Su-27 (6), Su-33	343	IR	120
R-33A	Р-33А	AA-9/Amos	MiG-31 (6)	490	SARH	160
R-60	Р-60	AA-8/Aphid	Su-24 (2), Su-25 (2), MiG-23 (4), MiG-27 (2)	45	IR	10
R-73	Р-73	AA-11/Archer	MiG-29 (6), MiG-31 (4), Su-24 (2), Su-25 (2), Su-27 (10), Su-33	110	IR	30
R-77	Р-77	AA-12/Adder	MiG-29 (6), MiG-31 (4), Su-25 (2), Su-27 (10), Su-33	175	Radio command +ARH	90

AIR-TO-GROUND WEAPONS

While the Su-27 was originally designed as an air-to-air interceptor, the carrier-based multi-role Su-33 carries a wide variety of air-to-ground ordnance including missiles, unguided rockets, and free-fall bombs. In this chapter we examine the different weapons, their capabilities, and their intended roles.

▶ Use the right tool for the right job! Each weapon type is designed for a specific purpose. An anti-radiation missile is useless against trucks and vans. High-explosive, penetrating bombs aren't very effective against dispersed SAM sites. Before executing a mission, research the target and carry weapons appropriate for the task at hand.

Air-to-ground Missiles

Just as air-to-air missiles are tailored for long, medium, and close ranges, air-to-ground missiles are tailored to specific target types. The warheads and seekers are usually designed for specific purposes, such as attacking hostile radar sites and enemy ships; however, a few missiles are designed as "general purpose" weapons.

General purpose tactical missiles

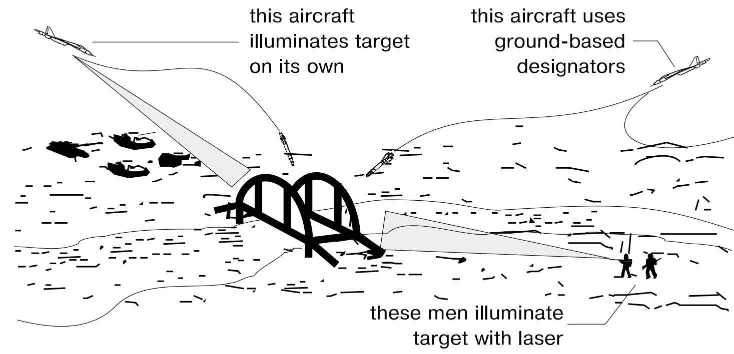
General purpose tactical missiles include the Kh-29 and Kh-25 families. These missiles can destroy field fortifications, railway and highway bridges, runways, bunkers, fortified missile launchers, ships, and surfaced submarines. The missiles are powered by solid-propellant rocket motors, which have a burn of some seconds and ensures initial boost up to speeds of about 2000-2300 km/h.

Guidance Types

Air-to-ground missiles use a variety of guidance types. Passive (non-emitting) systems use television or infrared guidance. For television guidance, the pilot designates the target via a picture displayed on the MFD and the missile guides to that object. Heat-seeking, IR systems, on the other hand, work like their air-to-air counterparts and home in on the heat generated by the target.

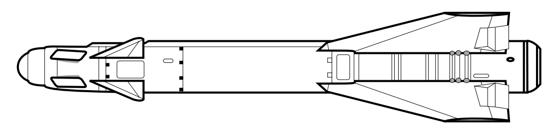
Active (emitting) systems transmit either a radar or laser beam to the target, then the missile follows the reflections from the target. In the case of the laser guided weapons, the laser designator may be "onboard" or "offboard." In the first case, the aircraft carries the necessary laser designator and the pilot locks it to the desired target. In the latter case, a separate system (possibly another aircraft or possibly troops on the ground) carries the designator and chooses the target.

To guide an air-to-ground missile, passive homing (TV or IR) or semi-active homing (radar or laser) can be employed. In case of semi-active homing, a target is illuminated by aircraft equipped with special opto-electronic systems, or by ground-based laser designators. The seeker head locks onto the illuminated target before missile launch.



6-12: Laser Designation Scenarios

Kh-29 / AS-14 Kedge

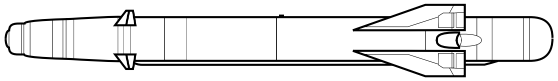


The most common air-to-ground guided missile is the Kh-29 (AS-14 'Kedge'). The weapon is effective against hardened targets (such as reinforced concrete shelters, concrete runways, major railway and highway bridges) and sea-based targets (ships and surfaced submarines). The weapon should be launched from an altitude between 200 meters and 5 km. Maximum launch range for the Kh-29 is about 10-12 km and maximum speed is 3000 km/h. The Kh-29 comes in the following major versions:

VERSION	GUIDANCE	WARHEAD, KG	RANGE, KM
X-29L	Semi-active laser homing	317	8-10
X-29TE	TV or passive IR homing.	320	20-30

The Kh-29T fire-and-forget version is capable of destroying large tonnage ships (up to 10000-ton displacement) such as torpedo boat or cruiser.

Kh-25 / AS-9 Karen



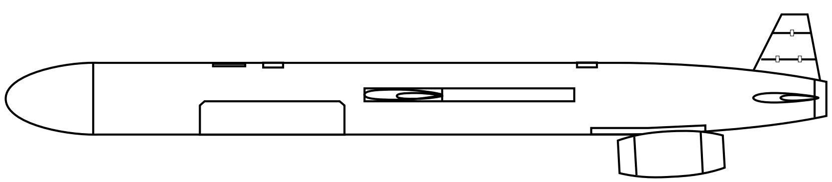
The Kh-25 (AS-9 'Karen') is another widely used air-to-ground missile, with a smaller warhead and shorter range than the Kh-29. The family includes both IR and Laser guided variants:

VERSION	GUIDANCE	WARHEAD, KG	RANGE, KM
X-25T	Passive IR homing	90	2-20
X-25L	Semi-active laser homing	90	10-20
X-25MP	Anti-Radar Missile	90	40-60

The X-25L missile, fitted with a laser guidance system, is designed to engage a wide range of small targets, such as radar sites, command posts and tactical missile launchers. In terms of performance characteristics it can be compared to the American AGM-65E 'Maverick'. The target under attack can be illuminated by both the airborne and ground-based designation stations. The Kh-25MP anti-radar version is described separately in the anti-radar missile section.

All the Kh-25 missiles share a common aerodynamic configuration and are fired from an APU-68 airborne launcher. The missiles can fly at up to 3200 km/h.

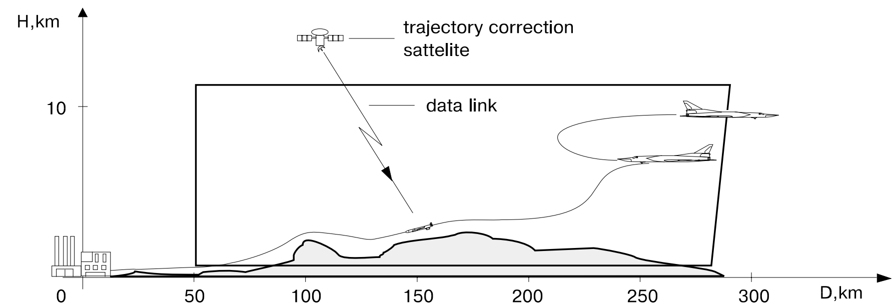
Kh-55 / AS-15 Kent



The Kh-55 (AS-15 'Kent') designed by the Raduga (Rainbow) OKB is a subsonic cruise missile flying at Mach 0.5-0.75. The missile can destroy fixed ground targets with known coordinates at ranges up to 300 km.

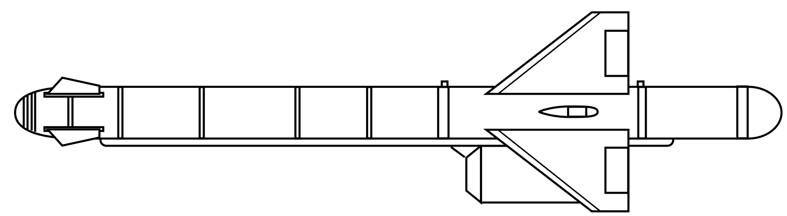
The Kh-55 is fitted with a dual-flow turbojet engine. Its inertial guidance with terrain following integrated with a satellite navigation system allows the missile to fly at altitudes of 40-110 meters and to hit targets with an accuracy of 18-26 meters.

This missile can be launched from a beam or drum launcher. After the launch, the Kh-55 flips out the wings and lowers the engine from its body, then descends to an altitude of about 100 meters. Typically, the pilot can launch the Kh-55 missile at a range of 50-250 km and at altitudes of 200-12000 m. The missile's trajectory can be corrected by the satellite.



6-13: Kh-55 Flight Profile

Kh-59 / AS-13 Kingbolt



The Kh-59 (AS-13 'Kingbolt') is a tactical missile intended for destroying targets with known coordinates and located at ranges up to 115 km from the point of launch. The dual-flow turbojet engine allows the missile to fly at a cruising speed of about 1000 km/h maintaining an altitude of 100 meters above the ground. The Kh-59 uses inertial guidance during the main part of flight and TV homing on approach to the target.

The navigator onboard the launching aircraft receives the image of the terrain seen by the missile's TV seeker, and can correct the missile's trajectory using the map stored onboard . When the Kh-59 approaches the target area, the navigator identifies the target and guides the missile directly to it. This method ensures very high accuracy (about 2-3 m).

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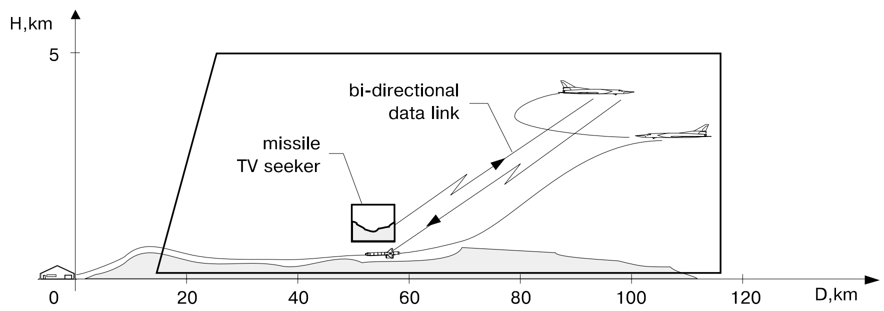


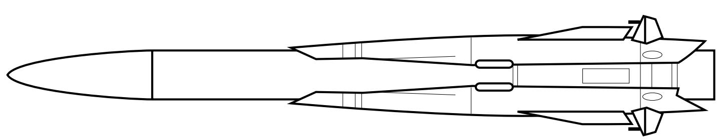
14: Kh-59 Flight Profile

Anti-radar Missiles

Technically speaking, anti-radar missiles are semi-active guided, homing in on the transmissions from someone else's radar. The idea is simple: blind the enemy by taking away his most effective search mechanism. Anti-radiation missiles (ARMs) may engage a wide variety of targets including early-warning radars, SAM search/guidance radars, and air traffic control radars.

Anti-radar missiles are "suppression" devices designed to keep the enemy from using his radar systems. Actually destroying those systems, however, is an elusive goal. Many of the target radar systems are capable of detecting the inbound missiles as soon as they separate from the launching aircraft. The radar system will usually shut down well before the missile can home in. In some cases the missile may remember the location of the transmitter and continue in, but if it misses by more than a few meters the radar transmitter may go unharmed. Nonetheless, forcing the system to shut down results in a "mission kill" that prevented it from acting against friendly aircraft.

Kh-31P / AS-12 Kegler

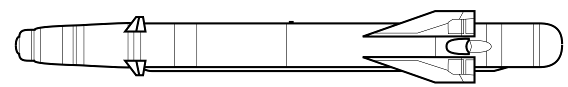


The Kh-31P (AS-12 'Kegler') anti-radar missile is derived from the Kh-31A anti-ship missile (described separately). The weapon is effective against all existing types of long-range and medium-range air defense radar, air traffic control radar, and early warning radar. The Kh-31P was created to overcome air defenses, in particular those equipped with the U.S.-built 'Patriot' air defense missile system.

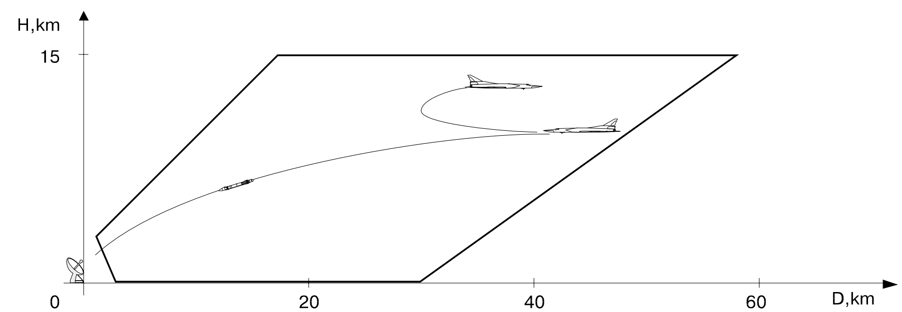
The Kh-31P uses an integral powerplant fitted with a combined solid-propellant/ramjet engine developed by the OKB Soyuz (Union). The combustion chamber of the mid-flight ramjet engine houses a solid-propellant booster which, after the Kh-31P leaves the aircraft, accelerates the missile to the ramjet sustainer minimum ignite speed (about 1000 km/h). After the booster has finished its task, it is ejected from the combustion chamber of the ramjet sustainer.

The Kh-31P is arguably the most sophisticated missile of its type currently in service. It can gain the upper hand of any enemy SAM launcher in a "dueling situation" as its high speed makes the missile hard to detect. The missile uses a passive radar seeker capable of acting in a broad band of frequencies. The onboard electronic equipment of the Kh-31P can employ several seeker modes including automatic search and guidance mode. After launch the missile is completely autonomous. The Kh-31P missile can fly at a maximum speed of about 4700 km/h. Typically, the pilot can launch the missile at ranges of 5-100 km and at altitudes of 50-15000 m.

Kh-25MP / AS-10 Karen



The Kh-25MP (AS-10 'Karen') anti-radar missile belongs to the Kh-25 family, has a passive radar seeker and engages enemy radar at a distance of 40-60 km. The maximum speed of the missile is about 3200 km/h. The Kh-25MP can be compared to the American 'Harm' missile, however it has a more powerful warhead and slightly shorter range.

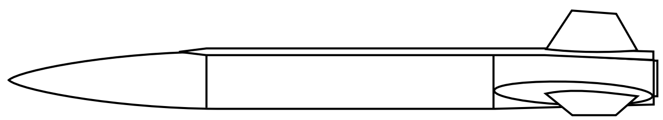


6-15: The Kh-25MP Launch Envelope

Anti-ship missiles

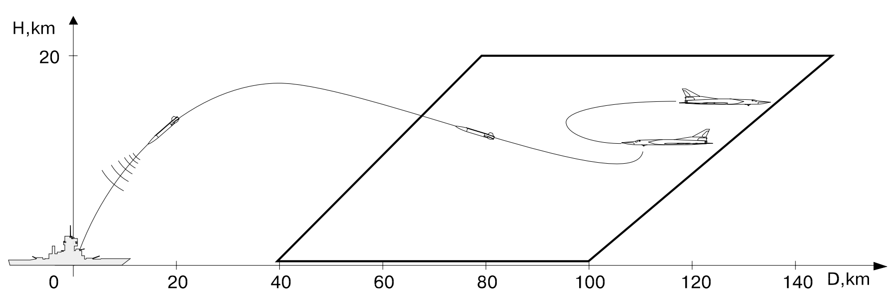
As the name implies, anti-ship missiles are designed for use against naval vessels. Anti-ship missiles must generally fly relatively long ranges, survive defenses designed specifically to down incoming missiles, and do substantial damage to the target. Because of the great threat posed by an anti-ship missile, naval vessels use a combination of SAMs and high rate-of-fire cannons situated on multiple ships to knock inbound missiles out of the sky. Consequently, anti-ship missiles are usually launched in large volleys in hopes that one or two missiles actually penetrate the defensive screen and strike the target.

Kh-15 / AS-16 Kickback



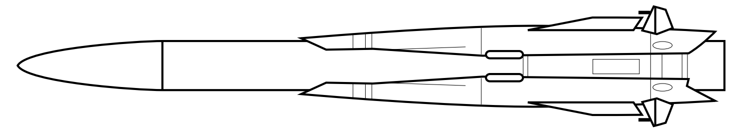
The Kh-15 (AS-16 'Kickback') is a supersonic aeroballistic missile intended for destroying ships such as cruisers or destroyers and can also be utilized against ground targets. The missile has a solid-propellant rocket motor. During cruise flight (normally, at Mach 5), the missile climbs, and at the terminal part of flight it follows a ballistic trajectory.

The Kh-15 is fed targeting data by the launch platform and uses inertial guidance and active radar homing at the terminal part of flight. It has a launch range from 50 to 160 km. This missile can be launched from a beam or drum launcher.



6-16: The Kh-15 Launch Envelope and Flight Profile

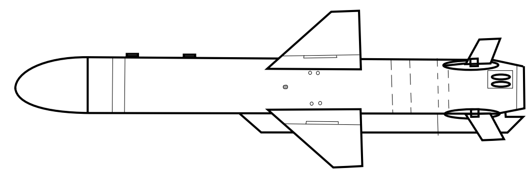
Kh-31A / AS-12 Kegler



The construction of the Zvezda Kh-31A (AS-12 'Kegler') supersonic anti-ship missile is similar to that of the Kh-31P. The Kh-31A employs an active radar homing system, and a more powerful warhead. The missile can be launched at stand-off ranges and is capable of destroying targets in conditions of ECM and under any meteorological conditions.

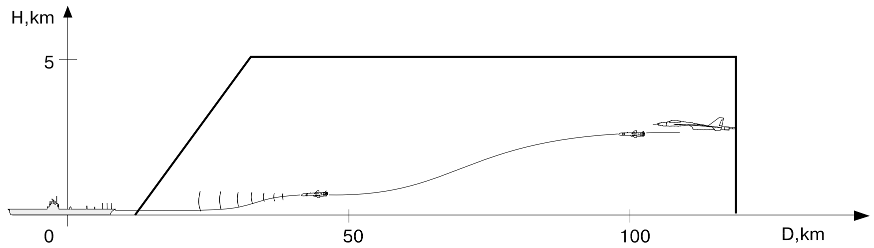
The Kh-31A is fitted with a 90-kg piercing warhead to effectively destroy surface vessels with displacement of up to 4,500 tons. Typically, the pilot launches the Kh-31A at ranges of 5- 50 km and at altitudes of 50-15000 m.

Kh-35 / AS-17 Krypton



The Kh-35 (AS-17 'Krypton') is an anti-ship missile flying at transonic speeds (1100 km/h). The Kh-35 has a two-stage configuration: the missile is fired from the launcher by a solid-propellant motor, then the small-size cruise turbojet engine, operating on aviation kerosene, takes over its sustainer flight. For better handling the size of the missile was reduced by creating folding wings, control surfaces and stabilizers. The aerodynamic surfaces of the missile open up, as soon as it leaves the launching platform.

The Kh-35 employs combined guidance: during the initial part of flight an inertial guidance system guides the missile to a pre-programmed point provided by the navigation system or AWACS. In the terminal part of flight, the missile engages its active radar homing system, which can work in conditions of severe ECM and enemy fire. The missile cruises at extremely low altitudes (3-15 meters, depending on sea conditions), which greatly hampers interception by shipborne antimissile systems. The 145-kg piercing blast-fragmentation warhead allows reliable engagement of surface vessels up to cruiser class. The missile is normally fired at a stand-off range within its launch envelope (see the figure below).



6-17: The Kh-35 Launch Envelope and Flight Profile

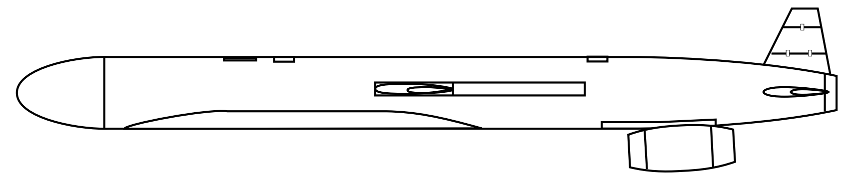
Kh-41

No Picture Available

One of the most deadly anti-ship missiles in the Russian arsenal, the Kh-41 can be launched from both aircraft and ships. A supersonic missile, it is effective against large, cruiser-class ships, even in the presence of heavy electronic countermeasures. Being very manoeuvreable and flying at very low altitude, the missile is difficult to detect and intercept.

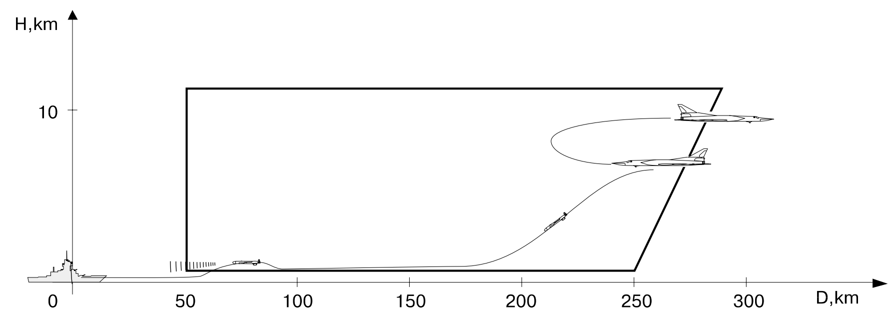
The Kh-41 uses inertial guidance coupled with an active radar seeker, giving the missile true fire-and-forget capability. The missile can also track active jamming sources. The air-launched version has a range of 200km (the ship-launched version can travel 250km) at speeds ranging from mach 2.1 to mach 3. The Su-33 can carry only one Kh-41, but it is easily the most sophisticated missile available.

Kh-65



The construction of the Kh-65 (NATO and USA designations are unknown) anti-ship missile is similar to that of the Kh-55. The Kh-65 can destroy ships such as cruisers or destroyers using targeting data relayed from the launch platform.

The missile can engage targets stand-off, without the launching aircraft entering into the ships air defence area. While cruising, the Kh-65 travels at altitudes of 40-110 meters at Mach 0.5-0.75. Unlike the Kh-55, the Kh-65 switches to homing upon approach to the target. For this purpose it has an active radar seeker, ensuring high precision guidance on the final approach to the target. Typically, the pilot can launch the Kh-65 missile at ranges of 50-250 km and at altitudes of 200-12000 m. This missile can be launched from a beam or drum launcher.



6-18: Kh-65 Launch Envelope and Flight Profile

The table below contains the main characteristics of various types of Russian air-to-ground missiles.

<<NOTE: The ranges in this table do not match the text above. Which figures are correct?>

TYPE	USA/NATO	CARRIER (#)	WEIGHT, KG	RANGE, KM	TARGETS
Kh-15	AS-16/Kickback	Tu-95 (6), Tu-142 (6), Tu-22M3 (8)	1200	150	ships
Kh-25MP	AS-9/Karen	MiG-27 (2)	300	10	radar
Kh-25MT	AS-9/Karen Su-24 (4),	MiG-27 (2), Su-25 (4)	300	20	ground targets
Kh-25MTL	AS-9/Karen	MiG-27 (2), Su-24 (4), Su-25 (4)	300	20	ground targets
Kh-29TE	AS-14/Kedge	MiG-27 (2), Su-24 (3), Su-25 (4), Su-33 (4)	680	12	ground targets, ships
Kh-31P	AS-12/Kegler	MiG-27 (2), Su-24 (2), Su-25 (2), Su-33 (6)	600	100	radar
Kh-31A	AS-12/Kegler	MiG-27 (2), Su-25 (2), Su-33 (6)	600	50	ships
Kh-35	AS-17/Krypton	MiG-27 (2), Su-33 (6), Tu-142 (8)	600	130	ships
Kh-55	AS-15/Kent	Tu-95 (4)	1250	300	ground targets
Kh-59m	AS-13/Kingbolt	Su-24 (2), Su-33 (2)	920	115	ground targets
Kh-65	Unknown	Tu-142 (6)	1250	280	ships
Kh-41		Su-33 (1)	4500	200	ships

Bombs

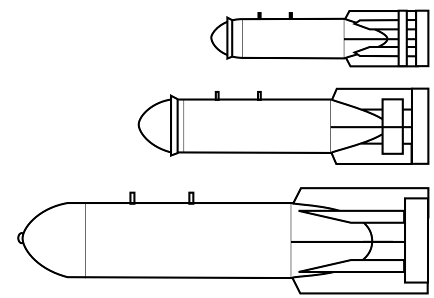
Bombs are used for destroying comparatively large and fortified targets. After the release the bomb either follows a ballistic trajectory (free-fall bombs), or moves under control of its guidance system (guided bombs).

A typical bomb consists of a cylindrical body equipped with stabilizers, a charge of explosive, and a fuze. The most common bombs are blast (Russian designation FAB), fragmentation (OAB), concrete piercing (BetAB) and incendiary (ZAB) bombs, and combined action bombs, for example, blast-fragmentation (OFAB) bombs. All these types of bombs can be monolithic or cassette.

Free-fall bombs

Free-fall bombs have no guidance or control capabilities, falling along a relatively predictable path depending on the flight profile of the aircraft at the time of release.

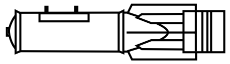
FAB-250, FAB-500, FAB-1500 General Purpose Bombs



The FAB-250, FAB-500, FAB-1500 general purpose bombs contain charges of high explosive. FAB stands for Blast Aviation Bomb in Russian, and the number in the bomb designation denotes its caliber in kilograms: 250, 500, and 1500 kg, correspondingly. These bombs damage targets mainly by shock wave, and they are effective against defense facilities, industrial facilities, railway junctions, ships, and soft targets.

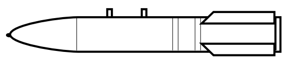
General purpose bombs are the cheapest of all major air-to-ground munitions and can be delivered using any of the bombing methods described above. For effective delivery it is desirable to release general purpose bombs at a speed of 500-1000 km/h and at altitudes of 300-5000 m.

OFAB-250 Blast-fragmentation Bomb



The OFAB-250 is a 250kg blast-fragmentation bomb (OFAB stands for Blast Fragmentation Aviation Bomb in Russian) that combines the effects of both the general purpose and fragmentation bombs. The blast creates a cloud of small fragments and shrapnel. This weapon is effective against personnel and lightly armored vehicles. It is released at airspeeds from 500 to 1000 km/h and at altitudes from 500 to 5000 meters using any delivery method.

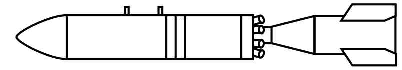
PB-250 Retarded Bomb



The PB-250 is a 250kg blast-fragmentation bomb fitted with a drogue chute deployed when the bomb is released. The parachute increases air resistance of the bomb and, consequently, greatly reduces its speed. This allows the pilot to bomb from low altitudes, since the aircraft will have enough time to leave the blast radius before the weapon detonates.

The bomb contains a blast-acting charge, the required fragmentation being provided by special design of the bomb casing. The PB-250 is effective against personnel, lightly armored vehicles, truck convoys, parked aircraft on airfields, etc. Delivery the weapon from low altitudes of 100-300 meters and at airspeeds of 500-1000 km/h.

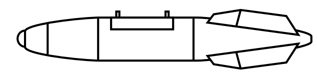
BetAB-500ShP Concrete Penetrating Bomb



The BetAB-500ShP concrete penetrating bomb (BetAB stands for Concrete-Piercing Aviation Bomb in Russian) is a special purpose bomb effective against reinforced concrete bunkers and runways. As opposed to a general purpose bomb, the BetAB has a stronger frame and a hardened nose. Given sufficient kinetic energy, the bomb penetrates through the concrete and then explodes. The BetAB-500ShP is fitted with a drogue chute and a solid-propellant booster. The parachute initially slows the bomb down giving the aircraft more time to clear the impact zone. The parachute is then released as the booster ignites accelerating the bomb to the speed necessary to penetrate hardened concrete.

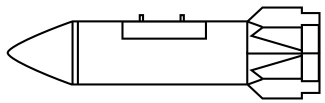
Deliver the weapon from altitudes of 150-500 m at airspeeds from 550 to 1100 km/h.

ZAB-500 Incendiary Bomb



The ZAB-500 is a 500-kg incendiary bomb (ZAB stands for Incendiary Aviation Bomb in Russian) used against enemy personnel, industrial facilities, railway stations, etc. Its casing is filled with a combustible mixture based on thickened petrochemicals. To spread viscous mixture and ignite it, the bomb uses a bursting charge and an igniting cartridge.

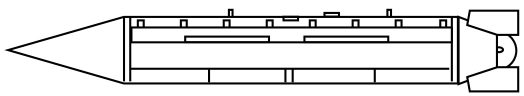
RBK-500 Cluster Bomb



Cluster bomb dispensers are actually thin-walled casings containing small-sized fragmentation, antitank, incendiary, concrete-piercing bomblets. Each bomblet weighs up to 25kg.

Release of the RBK-500 bomb (RBK stands for Expendable Bomb Cassette in Russian) arms a proximity fuze, which detonates within pre-set time at a pre-set altitude. The casing breaks apart into two halves and ejects the bomblets in a dense cloud. The bomblets cover an area which depends on the speed and altitude at which the casing breaks apart. Thus, unlike a usual bomb, a cluster bomb destroys targets in a considerably wide area. Delivered at low altitude for maximum effect.

KMGU Cluster Bomb



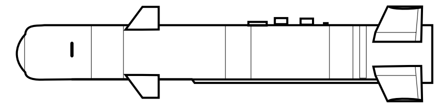
Bomblets can also be dispensed from an aircraft-mounted multi-purpose nondrop pod (Russian designation KMGU stands for Unified Container of Small Loads) containing up to four compartments. The pilot can dispense submunitions from two compartments at a time or from all the compartments simultaneously. The submunitions should be dispensed in level flight at low altitudes (50-150 m) and at airspeeds of 500-900 km/h.

Guided bombs

Guided bombs are among the most effective and “smart” types of air-to-ground weapons, combining high efficiency of target destruction with relatively low cost. This kind of weapon is effective against fixed ground targets (railway bridges, fortifications, communications, junctions) and is fitted with a blast or armour-piercing warhead.

Like air-to-ground missiles, guided bombs use TV, IR, and laser targeting techniques. As with missiles, weather and moisture degrade targeting capability.

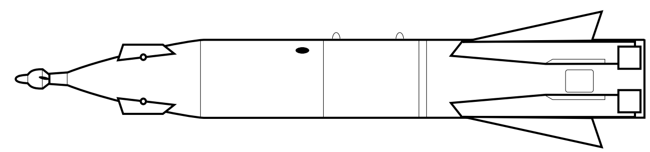
KAB-500KR/L TV/IR Guided Bomb



The KAB-500 guided blast bomb (KAB stands for Controlled Aviation Bomb in Russian) employs TV or IR homing. The TV-guided KAB-500KR is normally used in daytime in conditions of fair visibility whilst the IR-guided KAB-500L is mostly applied at night and against camouflaged targets. The warhead can be either armor-piercing or blast. The TV seeker head includes a TV camera, a microprocessor and a power supply unit. The angular field of vision of the TV seeker is equal to 2-3°. After lock onto a target and release, the bomb becomes completely autonomous. To correct its trajectory, the bomb uses control surfaces, which ensure accuracy of about 3-4 meters.

The KAB-500 is normally delivered using a shallow dive bombing technique. Typically, the pilot releases this bomb at airspeeds of 550-1100 km/h and at altitudes of 500-5000 meters.

KAB-1500L Laser Guided Bomb



Front-line and long-range aircraft often carry the powerful KAB-1500L laser-guided bomb. It is effective against super-hardened targets, hardened fortification installations, nuclear storage bunkers, strategic command centers, etc. The KAB-1500L employs semi-active laser homing with impact accuracy of about 1-2 meters. The bomb is fitted with either a penetrating warhead (capable of penetrating up to 2 meters of concrete), or an explosive warhead (which blasts a crater wider than 20m in diameter). The pilot can employ the bomb at altitudes from 500 to 5000 meters while flying at airspeeds of 550-1100 km/h.

The table below contains specification of some popular bombs:

TYPE	CARRIER (#)	WEIGHT, KG	WARHEAD WEIGHT, KG	WARHEAD TYPE
FAB-250, OFAB-250, PB-250	Su-33 (12), Su-24 (18), Su-25 (10), MiG-27 (8), MiG-29 (8), Tu-95 (60)	250	230	blast blast-fragm. blast-fragm.
FAB-500	Su-33 (6), Su-24 (8), Su-25 (8), MiG-27 (4), MiG-29 (4), Tu-95 (30)	500	450	blast
FAB-1500	MiG-27 (2), Tu-95 (18)	1400	1200	blast
BetAB-500 ShP	MiG-27 (2)	425	350	concrete-penetrating
ZAB-500	Su-33 (6), Su-24 (7), Su-25 (8), MiG-27 (4), MiG-29 (4)	500	480	incendiary
RBK-500	Su-33 (6), Su-24 (8), Su-25 (8), MiG-27 (4), MiG-29 (4)	380	290	cluster/fragm.
KAB-500	Su-33 (6), Su-24 (4), Su-25 (8), MiG-27 (2)	560	380	armour-piercing or blast
KAB-1500L	Su-24 (2), MiG-27 (1)	1500	1100	blast
KAB-1500 KR	Su-33			

Unguided Rockets

Despite the existence of high accuracy weapons, unguided rockets remain a powerful and flexible air-to-ground weapon, combining high combat efficiency and simplicity of use with low cost. An unguided rocket has a relatively simple design and consists of a fuse and a warhead in the nose part followed by the rocket body with a solid-propellant motor and stabilizer. Unguided rockets are usually placed in special rocket pods.

The rocket motor begins to operate at the moment of launch. Due to thrust provided by the motor, which usually operates from 0.7 to 1.1 seconds depending on the rocket type, the rocket accelerates to 2100-2800 km/h. After the motor burns out, the rocket coasts, gradually slowing down because of air resistance. Like a projectile, the unguided rocket follows a ballistic trajectory. To provide steady flight, a rocket has a stabilizer located in its tail part. It serves to align the longitudinal axis of the rocket with its velocity vector. As unguided rockets are usually carried in launching pods, the stabilizer fins are kept folded inside the launch tubes of the pod. When the pilot launches the rocket, the stabilizer fins flip out into a fixed position.

Some types of unguided rockets stabilize by spinning themselves about the longitudinal axis. To spin, a rocket can utilize specially shaped stabilizer fins (for small caliber rockets), or rifled nozzles in the launch tubes. Angular velocity of rotation ranges between 450 rpm and 1500 rpm and develops within a short interval after the launch.

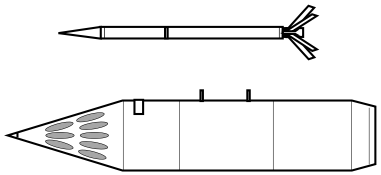
Depending on combat tasks, the pilot can employ unguided rockets of different caliber (from 57mm up to 370mm in diameter), fitted with fuses and warheads of appropriate types. A fuse can detonate on hitting the target, as, for example, in the case of an armor-piercing warhead, or at a certain distance from the launching platform, as in the case of a flare warhead.

Hit accuracy is characterized by an effective range, which depends on the type of unguided rocket. Since a rocket flies without any guidance, its accuracy decreases as the distance to the target increases.

Each type of unguided rocket has a specific possible launch zone limited by effective launch range and by safety range. The safety range depends on the warhead type and weight and should prevent the launching aircraft from being damaged by the debris after the warhead explosion.

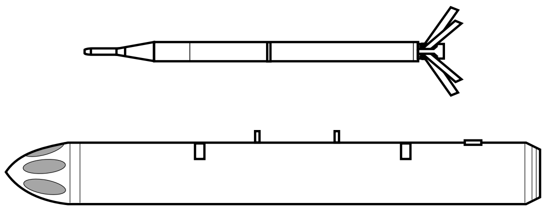
The pilot mostly employs unguided rockets at airspeeds of 600-1000 km/h while diving 10-30°. By manoeuvreing the aircraft, the pilot should line up on the target. Before the aircraft enters the rocket launch envelope, the pilot should place the Aiming Reticle on the target and on entering the launch envelope pull the trigger to launch.

S-8 Rocket



The S-8 is a medium-caliber, unguided rocket (80-mm in diameter) placed into the twenty-canister B-8 rocket pod. The S-8 has an effective range of 2000m. The margin of error is roughly 0.3% of launch range; rockets fired at a range of 2000m hit within a circle of 6m in diameter. The S-8 is normally deployed with a shaped-charge fragmentation warhead effective against soft targets. Armor-piercing (capable of penetrating 0.8m of reinforced concrete) and fragmentation warheads are also available. warhead

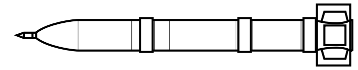
S-13 Rocket



The S-13 is a 132mm, unguided rocket placed in the five-round B-13 rocket pod. It is effective against fortified installations and hardened facilities (fixed emplacements, bunkers, hardened aircraft shelters, and runways). These unguided rockets can be fitted with warheads of various types. The concrete-piercing warhead can penetrate 3m of ground cover or 1m of reinforced concrete. The S-13 has an effective range of 3000m.

The S-13T variant carries a two-stage penetrating warhead which detonates inside the target after piercing the protective covering (up to 6m of ground cover or up to 2 m of reinforced concrete). When the rocket hits a runway, it damages an area of about 20 square meters. The blast-fragmentation warhead of the S-13OF version produces about 450 fragments weighing 25-35 grams each, effective against lightly-armored vehicles.

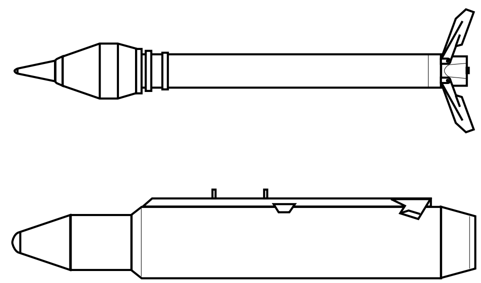
S-24 Rocket



The S-24 is a large caliber (240-mm) unguided rocket fitted with a powerful solid fuel rocket motor. The motor operates for 1.1 seconds accelerating the rocket and providing a stabilizing spin. The S-24 rocket can be fitted with a blast fragmentation warhead containing 23.5 kg of high explosive. The body of the warhead is perforated and offers special induction hardening that provides very even fragmentation. After detonation, the body breaks up into 4000 fragments having an effective radius of 300-400 meters.

The rocket is usually fitted with a proximity fuse, detonating over the target at an altitude of about 30 meters. To destroy hardened targets, the S-24 may carry a delay-after-impact fuse. The warhead housed into a strong casing pierces the covering of the target and detonates inside.

S-25 Rocket



The S-25 is a super-heavy unguided rocket housed in an expendable container. Inside its container, the rocket's four stabilizer fins are folded between four skewed jet nozzles providing stabilization spin-up.

There are several versions of the S-25 rocket in service with varying warheads effective against different target types. The S-25-O fitted with a fragmentation warhead and a radio proximity fuse is effective against personnel, transport, parked aircraft, and other soft targets. The S-25-OF with a blast fragmentation warhead destroys lightly armored vehicles, buildings, and personnel. The S-25-OFM has a modernized strengthened penetrating warhead, which is effective against hardened facilities and warehouses, shelters and other protected targets. The S-25 has an effective range of 2000 meters with a margin of error of about 0.3% of launch range (rockets fired at maximum of 2000m will land within a 6m diameter).

The table below contains specification for various types of unguided rockets:

TYPE	CARRIER (#)	RANGE, KM	WEIGHT, KG	WARHEAD TYPE
S-8B	MiG-27 (80), MiG-29 (80), Su-24 (120), Su-25 (160), Su-33 (120)	2.2	15.2	concrete-piercing
S-13OF/S-13T	MiG-27 (20), MiG-29 (20), Su-24 (30), Su-25 (40), Su-33 (30)	2.5	68/67	blast-fragmentation/ penetrating
S-24B	MiG-27 (4), MiG-29 (4), Su-24 (4), Su-25 (8)	2	235	blast-fragmentation
S-25OF	Su-24 (6), Su-33 (6)	3	380	blast-fragmentation
S-25OFM	Su-24 (6), Su-33 (6)	3	480	penetrating

Cannon Straffing

The cannon is located in the starboard wing root extension and is normally used in conjunction with the laser rangefinder. The cannon is extremely accurate, having a fire rate of 1,500 rounds per minute, with 150 rounds ammunition. The barrel of the GSh-301 has a 2,000-round life, equivalent to 80 seconds of fire at usual 1500 rpm. The cannon is fixed in the forward direction.

During an attack on ground targets, the cannon and unguided rockets are employed in effectively the same way. The main differences are the maximum effective range and the minimum range (dictated by firing safety), which for GSh-301 are 1800 and 700 meters, respectively.

CHAPTER 7

Training

Defense Visual Information Center - Department of Defense

TRAINING MISSIONS

Learning to fly a modern combat jet is no easy task. To assist you, Flanker 2.0 contains a series of narrated training missions. Each individual mission consists of a pre-recorded track file. Playing the track file lets you watch an experienced instructor pilot demonstrate the specific task while audibly describing the procedure. These training missions are designed to teach you the basics on how to successfully operate the Su-27 and Su-33 Flanker aircraft. It is by no means designed to teach you all that you need to know about the hundreds of combinations of weapons systems, payloads and situations you will be presented with. Reading the entire manual will allow you to become more familiar with your aircraft and it's capabilities.

Certain instruments and skills are covered in detail and then referred to in later training missions, so it is advisable to go through the training missions in order. It will be assumed in later missions that you are familiar with the workings of the controls shown in previous missions.

At a minimum, you should review the training on:

- Heads-up Display (HUD)
- Multi-Functional Display (MFD)
- Instrument Modes
- Beyond Visual Range (BVR) mode
- Searching for Surface Targets

There are additional instructions for creating your own training missions in the README.TXT file.

7-1: Training Mission Screen

While playing a training mission you may take command of the aircraft at any time by pressing **ESC**, but we recommend you wait until either the instructor You may also restart the mission in order to take control from the beginning. You may end a training mission at any time by pressing the **Control+Q** keys.

The missions are divided into ten categories. Each category may contain multiple missions. Below is a narrative of each of the training missions.

Free Flight

This section introduces you to the basics of the Flanker.

Introduction to the Flanker:

- The Su-27 Flanker is a supersonic all-weather air-superiority fighter. It has a lookdown/shoot-down weapons system, complemented by beyond visual range air-to-air missiles.
- It is 72 feet in length, with a wingspan of 48 feet.
- It can reach speeds in excess of mach 2, has a range of 2100 miles and can attain an altitude of 59,000 feet.
- The Su-27 has broken a number of speed records set by the American F-15 Eagle.
- It can out-turn and accelerate faster than any variant of the F-18 Hornet in a dogfight (As reported by Inside the Pentagon, 11 Feb 99).
- The Flanker is being used in the air forces of Russia, the Ukraine, Byelorussia, Georgia, China, India and Vietnam.
- Rudders are located on the rear part of the two vertical tailfins. These will allow the aircraft to yaw smoothly right or left. They are also used to control the direction of movement when the aircraft is taxiing on the ground.

- The tailerons are located at the rear of the aircraft and provide the pilot with the ability to change the angle of pitch.
- The white tailcone located between the two engine nacelles reduces drag and is used to store the braking parachute and the chaff/flare dispenser.
- Currently moving on the back portion of the wing are the differential flaps or flaperons. These provide extra lift for take offs and drag for landings.
- On the front edge of the wing is the leading edge flaps or slats, which are automatically driven. These provide extra lift when manoeuvreing and during take off and landing.
- The airbrake is used to reduce airspeed quickly during manoeuvres or to reduce pitch angle on approach and the length of the landing.
- The Flanker has 10 weapons pylons and can carry a large combination of air-to-air and air to ground ordnance.
- The Su-33 is the naval variant of the Flanker. The most apparent difference is the canard winglets located below and to the rear of the cockpit. The Su-33 also has folding wings, a tail-hook and a 10-ton internal fuel capacity.

Heads-up Display (HUD):

This training mission will go over the basics of the Heads-Up Display. Read about the HUD in chapter 3.

Introduction to the Instrument Panel:

This mission reviews the location of the major instruments in the cockpit. Read about the instruments in chapter 3.

Multi-Functional Display (MFD):

This mission reviews the location of the Multi-Functional Display. Read about the MFD in chapter 3.

Take Off

These missions start the user on the ground, ready for takeoff.

Light Takeoff:

This mission reviews the steps to perform a light take-off. A light payload is a takeoff weight of less than 22,000 kilograms.

- Engage the wheel brakes by holding down the **W** key.
- Missions start with the engine already on. Increase throttle to full military power by pressing the **Page Up** key or the **Plus** key on your number pad until the RPM gauge reaches 100%.
- At 100% power, release the wheel brakes with the **W** key.
- Move straight down the runway. If necessary, use your rudders to steer. The rudder keys are the **Z** and **X** keys.
- At a speed of 250 kilometers, rotate by pulling back smoothly on the stick.
- Raise the gear when the altimeter shows a positive rate of climb by selecting the **G** key. If you do not raise the gear, an audio reminder will sound.

Heavy Takeoff:

This mission reviews the steps to perform a heavy take-off. A heavy payload is a takeoff weight of more than 28,000 kilograms.

- A heavy payload is a takeoff weight of more than 28,000 kilograms.
- Engage the wheel brakes by holding down the **W** key.
- To engage the flaps you would select the **F** key. The configuration display will show green below the aircraft figure when they are engaged.
- Missions start with the engine already on. Increase throttle to full military power by pressing the Page Up key or the Plus key on your number pad until the RPM gauge reaches 100%.
- At 100% power, release the wheel brakes.
- Increase power to maximum afterburner.
- Move straight down the runway. If necessary, use your rudders to steer. The rudder keys are the **Z** and **X** keys.
- At a speed of 280 kilometers, rotate by pulling back smoothly on the stick.
- Raise the gear when the altimeter shows a positive rate of climb by selecting the **G** key. If you do not raise the gear, an audio reminder will sound.
- When the altitude reaches 100 meters, raise the flaps by selecting the **F** key.

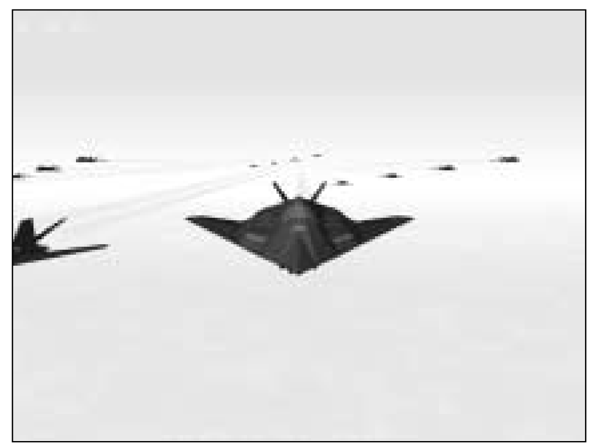
Landing

This category lets users practice landings.

Automatic Landing (with the the autoland option turned on):

This mission reviews the steps to perform an automatic landing. This mission starts out with the aircraft currently being flown manually.

- Insure that you are in Navigation mode by selecting the **1** key.
- Turn on the autopilot by selecting the **A** key.
- Select the Return mode by cycling through the modes using the **1** key. This mode will be indicated in the lower left corner of the HUD.
- Look at the MFD. Select the Minus key to zoom out and view the airfield that your aircraft is to land at. A line should be connecting your aircraft with the field.
- If you want to change airfields, use the(`) key to change the airfield you wish to land at.
- Once your aircraft has detected the approach beacon, the autopilot will change to Landing mode. This is seen on the HUD.
- The autopilot will automatically lower your landing gear and flaps and engage the airbrake as seen on the configuration display.
- Once your aircraft has touched down you might need to steer down the runway using the rudders. The rudder keys are **Z** and **X**. Also ensure that the throttle is at zero power by selecting the Page Down or minus key on the number pad.
- Release the drogue chute (if you are in an Su-27) by selecting the **P** key. Engage the wheel-brakes by depressing the **W** key until the aircraft comes to a complete stop.
- Once your aircraft has touched down you will need to steer down the using the rudders. The rudder keys are **Z** and **X**. Also ensure that the throttle is at zero power by selecting the **Page Down** or minus key (**-**) on the number pad.
- Release the drogue chute (if you are in an Su-27) by selecting the **P** key. Engage the wheel-brakes by depressing the **W** key until the aircraft comes to a complete stop.



Aerobatics

These missions allow you to practice standard manoeuvres.

Roll

- While maintaining an airspeed of 400 to 800 kilometers per hour, smoothly pull back on the stick until you have a nose up pitch angle of about 13 degrees.
- Deflect the stick to the desired direction of rotation, keeping a rate of rotation of about 60 degrees per second.
- Recover the wings level and pitch angle of about zero degrees.

Loop

- Ensure that your airspeed is between 600 and 900 kilometers per hour and your wings are level.
- Increase your throttle to full military power and pull back to a pitch angle of about 70 degrees.
- As you go past vertical, try to maintain a 15 degree angle of attack.
- Also correct any bank that developed during the ascending part of the manoeuvre.
- Look for the horizon. As it goes past, throttle back to 100% or less.

Half Loop

The half-loop is an excellent way to change direction and gain altitude.

- Ensure that your airspeed is between 600 and 900 kilometers per hour and your wings are level.
- Increase your throttle to full military power and pull back to a pitch angle of about 70 degrees.
- As you go past vertical, try to maintain an angle of attack of 15 degrees
- At the upper most point relax the stick to neutral and execute a half roll.
- Ensure that your angle of pitch is around zero degrees.

Reverse Turn

The reverse turn or Split-S is an excellent way to change direction quickly, while losing altitude. Do not try this manoeuvre unless you start at an altitude of at least 3000 meters.

- At an airspeed of between 400 and 900 kilometers per hour execute a half roll. Be sure to check the horizon.
- Smoothly pull back on the stick until you are flying level again.

Pugachev's Cobra

In this manoeuvre the Flanker is pulled to a high angle of attack and then returned to horizontal flight within 3-4 seconds. This causes an intensive loss of airspeed.

- Ensure that you have an airspeed of 350-450 kilometers per hour with the engine RPMs at 75%.
- Take the angle of attack and G limiter offline by selecting the K key.
- Pull back on the stick sharply to a pitch angle of 105 degrees and maintain it for about 3 seconds.
- As the nose goes past 70∞ nose up, return the stick to neutral.
- With the aircraft returning to level flight, add power as the nose comes to 30∞ pitch up angle.

Stalls and Spins

Learn how to recognize, avoid, and recover from dangerous stalls and spins.

Recovery from Spins and Stalls

In order to stay airborne an aircraft must produce enough lift. Flying at low airspeeds or high angles of attack may prevent the aircraft from generating enough lift and this may result in a stall. Coarse use of bank input or rudder at high angles of attack may result in a spin. If you experience a spin at an altitude of less than 2000 meters, eject immediately, as recovery is highly unlikely.

- Once you notice that the aircraft responds badly and the angle of attack is high, place the stick and the rudders in the neutral position and wait for the angle of attack to start to drop.
- If the aircraft starts to yaw and enters a spin, counter it by pressing the rudder pedal of the opposite direction. Slightly push the stick forward and throttle back to idle.
- If this does not work, push the stick farther forward and continue the opposite rudder.
- If the spin does not stop within 5-6 seconds, deflect the stick in the direction of the spin.
- If this does not help and your altitude is less than 1500 meters eject!
- As the rotation slows, release the rudder pedals and the stick to the neutral position at once. Any delay may result in a spin in the opposite direction.
- After you gain control of the aircraft, wait until it has reached a speed of at least 350 kilometers per hour, then power up and level off.

Carrier

Practice basic carrier operations with your Su-33.

Carrier Take-Off

- To engage the flaps you would select the **F** key. The configuration display will show green below the aircraft figure when they are engaged.
- Increase the throttle to afterburner. By pressing the **Page Up** key or the **Plus (+)** key on your number pad.
- Rotate by smoothly pulling back on the stick.
- Raise the gear when altimeter shows a positive rate of climb by selecting the **G** key. If you do not raise the gear, an audio reminder will sound.
- When the altitude reaches 100 meters, raise the flaps by selecting the **F** key.

Automatic Carrier Landing

This mission reviews the steps to perform an automatic carrier landing. This mission starts out with the aircraft currently being flown manually.

- Ensure that you are in Navigation mode by selecting the **1** key.
- Turn on the autopilot by selecting the **A** key.
- Select the Return mode by cycling through the modes using the **1** key. This mode will be indicated in the lower left corner of the HUD.
- Look at the MFD. Select the Minus key to zoom out and view the carrier that your aircraft is to land at.
- A line should be connecting your aircraft with the carrier.
- If the line connects you to another landing location, use the ` key to cycle through the landing locations until the carrier is selected.
- Once your aircraft has detected the approach beacon, the autopilot will change to Landing mode. This is seen on the HUD.
- The autopilot will automatically lower your landing gear, arrestor hook, flaps and engage the airbrake as seen on the configuration display.
- The number in the lower center of the HUD is the distance to the carrier in kilometers.

Air-to-Air

Basic Air Combat Modes

Beyond Visual Range (BVR) mode:

The BVR mode is used to acquire and engage targets at ranges of 25 to 150 kilometers.

- Press the **2** key to select this mode.
- Ensure that the radar is on. An “I” should appear on the left side of the HUD.
- You will see a box in the middle of the HUD that is your designator. You can use this to individually select targets to track or to lock on to.
- On the right of the HUD are 4 vertical lines. You will see them lighting up in sequence. This shows what vertical area your radar is currently scanning.
- Objects that your radar detects will appear as dashes on the HUD.
- You may cycle through the onboard weapons by selecting the **D** key.
- On the MFD you will see a cone that represents your radar coverage.
- The radar is in scan mode. Press the **2** key again to select the track while scan sub-mode. The weapons control system will automatically select the closest and fastest 8 scan contacts. These contacts will appear as triangles on the HUD.
- To lock onto a target, move the designator using the scan zone controls and select the **Tab** key. The vertical scan controls are the semi-colon (**;**) and period (**.**) period keys. The horizontal controls are the comma and forward slash keys.
- You will see the heading and velocity of the selected target.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- After your target has been destroyed, the system will revert to the scan mode.
- To unlock from a target press the **TAB** key again.

Close Air Combat (CAC) mode:

The CAC mode is used to acquire and engage visual targets at ranges of 25 kilometers or less.

- Press the **3** key to select this mode. A band will appear in the center of the HUD. Your objective is to manoeuvre your aircraft to place the target in that band.
- You may cycle through the onboard weapons by selecting the **D** key.
- You can move the band side to side with the comma (**,**) and forward slash (**/**)keys.
- To lock onto a target, select the **TAB** key.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- The **C** key toggles your cannon on and off. Once the target is in gun range, a target reticle will appear. Manoeuvre your aircraft so that the crosshairs line up with the target.
- To unlock from a target select the **TAB** key again.

Helmet Mode:

The Helmet mode is used to acquire and engage visual targets using the aiming reticule on your helmet.

- Press the **5** key to select this mode. A thick circle will appear in the center of the HUD. Using the number pad keys, you can move this circle onto a target.
- You may cycle through the onboard weapons by selecting the key.
- To lock onto a target, select the **TAB** key.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- To unlock from a target select the **TAB** key again.

Bore Site Mode:

The Radar Bore Site mode is used to acquire and engage visual targets at ranges of 25 kilometers or less.

- Press the **4** key to select this mode. A circle will appear in the center of the HUD. Your objective is to manoeuvre your aircraft to place the target in that band.
- You may also move the Bore circle using the scan controls. The vertical scan controls are the semi-colon (**;**) and period (**.**) keys. The horizontal controls are the comma (**,**) and forward slash (**/**) keys.
- You may cycle through the onboard weapons by selecting the **D** key.
- To lock onto a target, select the **TAB** key.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- To unlock from a target select the **TAB** key again.

Longitudinal Aiming Mode:

The longitudinal aiming mode is used to acquire and engage visual targets using the seeker on a missile. Press the **6** key to select this mode.

- A circle will appear in the center of the HUD. Your objective is to manoeuvre your aircraft to place the target in that circle. To lock onto a target, select the **TAB** key.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- To unlock from a target select the **TAB** key again.

Air-to-Ground

This category shows you how to find surface targets.

Searching for surface targets:

- Press the **7** key to select the Air to Ground mode.
- Press the "**I**" key to turn the radar on.
- A diamond will appear on the HUD. The diamond is the radar target designator, which shows where your radar is aimed. The circle is the Continuous Computed Impact Point or CCIP.
- Your task is to acquire and lock onto the target with your radar and then place the CCIP on the diamond by manoeuvreing your aircraft.
- You may cycle through the onboard weapons by selecting the **D** key.
- The MFD is in scan mode. Use the vertical control keys to move the scan zone up and down. The vertical scan controls are the semi-colon (**;**) and period (**.**) keys.
- Notice that the diamond is moving on the HUD.
- Once you are in the general vicinity of the target, go to the Wide Search mode by selecting the **+** key.
- Continue to search for the target with both the vertical and the horizontal scan controls. The horizontal controls are the comma (**,**) and forward slash (**/**) keys.
- Once you have the surface target in the box on the MFD, select the **+** key again to go to the Narrow Search mode.
- To lock onto a target, select the **TAB** key.
- Now manoeuvre your aircraft to place the CCIP over the diamond on the HUD.
- Ensure that you are in range using the range scale on the HUD.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- You have acquired the target. There are many different weapons that can be used in the Air to Ground mode, so please familiarize yourself with each weapon's abilities.
- To unlock from a target select the **TAB** key again.

Anti-Ship

Learn the basics for successfully attacking ships.

Anti-Ship:

- Selecting the **7** key will place you in the Air to Ground mode. This is the mode that is used to engage ships.
- Selecting the **I** key to turns the radar on.
- The MFD is in scan mode. Use the vertical control keys to move the scan zone up and down. The vertical scan controls are the semi-colon (**;**) and period (**.**) keys.
- Notice that the diamond is moving on the HUD.
- Once you are in the general vicinity of the target, go to the Wide Search mode by selecting the **+** key.
- Continue to search for the target with both the vertical and the horizontal scan controls. The horizontal controls are the comma (**,**) and forward slash (**/**) keys.
- Once you have the surface target in the box on the MFD, select the **+** key again to go to the Narrow Search mode.
- You will now see that there are crosshairs in the MFD. Once you have moved the crosshairs over the target select the **Tab** key to lock in on the target.
- Once you have a launch authorized cue (LA) on your HUD, you may shoot.
- To unlock from a target select the **TAB** key again.

Anti-Radar

Practice destroying hostile radar sites with this mission.

Anti-Radar:

- The Threat Warning System senses a SAM radar, manoeuvre your aircraft towards the general direction of the source.
- Press the **7** key to select the Air to Ground mode.
- You may cycle through the onboard weapons by selecting the **D** key.
- To lock onto a target, select the **TAB** key.
- If the SAM's radar is strong enough, and the missile's range parameters are met, you should get the launch authorized (LA) on your HUD.
- Once you have the launch authorized cue (LA) on your HUD, you may shoot.
- To unlock from a target select the **TAB** key again.

See the README.TXT file for instructions on creating your own training missions.

CHAPTER 8

Emergency Procedures

Defense Visual Information Center - Department of Defense

Onboard warning systems call your attention to battle damage, system malfunctions, enemy threats, or other dangerous situations. Correct interpretation of warning signals may save your aircraft, or at least save your life by providing sufficient time to eject.

MASTER WARNING SYSTEM

The Master Warning System (MSW) is designed to attract your attention to a specific failure. A Master Warning Light will flash and an alarm tone will draw your attention to the instrument panel.

The MWS indicates that one of the following has occurred:

- Impact with the ground is imminent – Accompanied by an "X" symbol on the HUD, your current flight path will result in a collision. The light flashes at 1 Hz and emits an audible alarm. Pull up immediately.
- Low fuel – The MWS light flashes at 1 Hz and is accompanied by an alarm beep for 10 seconds. The red ТОПЛИВО light on the fuel gauge also illuminates. Land as soon as possible.

- Landing gear is still deployed at a high airspeed – The warning light flashes at 1Hz and is accompanied by a warning beep. Both alarms cease when you retract the landing gear.
- Some onboard equipment has failed or taken battle damage – Check the instrument panel for individual warnings or failure indicators, such as a failed engine, failed hydraulic system, or malfunctioning radar. See later sections for more information on handling specific failures.
- Your aircraft is being painted by enemy radar – The MWS flashes at 5 Hz when the RWS detects enemy emissions. Flashing changes to 1 Hz when a lock-on has been detected. Check the threat warning display in the lower right corner of the instrument panel. Take evasive action as appropriate.
- The Missile Launch Warning System has detected an inbound missile – The MWS light is accompanied by the Missile Launch Warning light. Take evasive action immediately.

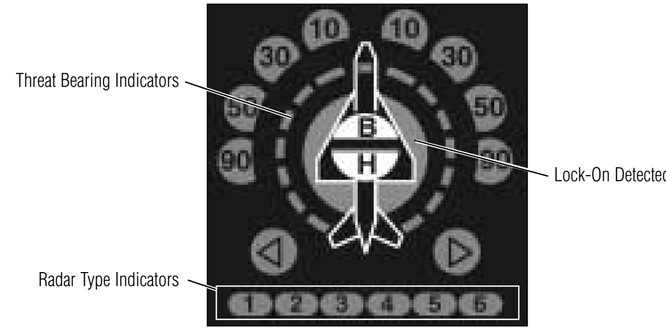
To reset the MWS, press the **shift + M** key.

RADAR WARNING SYSTEM

The SPO-15 “Beryoza” Radar Warning System (RWS) detects enemy radar signals and operates like any radar detector used in automobiles to locate police radar. Thanks to a more complicated antenna system (fitted in the tailcone) and more processing power, the RWS not only detects radar, but also indicates the bearing to the transmitter and the type of radar detected. A totally passive system, it merely listens for other’s emissions. This system is used in a variety of Russian aircraft including the MiG-29 Fulcrum , MiG-31 Foxhound, and Mi24P Hind.

The ten lights surrounding the MiG-21 picture illuminate to indicate the bearing to the transmiter. A flashing light indicates your aircraft is being painted occasionally by the emitter. A solid light indicates that a transmitter is tracking your aircraft. A red light surrounding the silhouette indicates a lock onto your aircraft. The six lights along the bottom of the RWS correspond, from left to right, to five categories of radar signals:

- Airborne radar
- Short-ranged SAM
- Medium-ranged SAM
- Long-ranged SAM
- Early warning radar
- AWACS



All Russian aircraft are equipped with an Identification Friend or Foe (IFF) system, allowing the RWS to distinguish between friendly and hostile radar sources. This system also replies to friendly emitters, alerting them that you’re not a hostile target.

MISSILE LAUNCH WARNING SYSTEM

The infrared MLWS detects the hot emissions produced by incoming missiles. A totally passive system, it watches for the type of heat produced by solid-propellant rocket motors. Its effective range varies depending on the intensity of the heat emission, but can generally spot inbound missiles up to 15 km away.

When the MLWS detects an inbound missile, the ПУСК symbol (meaning “launch” in Russian) illuminates and produces a warning beep at 2 Hz for five seconds. The MLS light also illuminates. After five seconds the audio alarm silences, but the warning light remains on until the system loses contact with the missile.

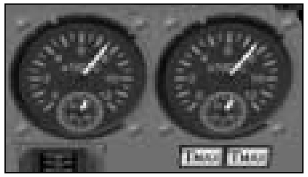
► **When the MLWS illuminates, take evasive action immediately!**

The voice messaging system also provides audible cues indicating where the missile is coming from. The system will announce “Missile at…” followed by a clock position such as “12 high” or “6 low.”

SYSTEM FAILURES

Eventually, all mechanical items, even modern, high-tech jet fighters, eventually break down especially when constantly exposed to enemy fire. Knowing how to respond to common failures will help you bring a damaged jet home safely. The MWS monitors many of the aircraft systems. The system can't monitor every aspect of the aircraft, but it will alert you when it detects a malfunction.

Engine failure



Engine failures are commonly caused by missile hits. Typically, the damaged engine shows an increased jet pipe temperature coupled with a loss of RPM. When the temperature increases beyond the permissible threshold, the corresponding Maximum Jet Pipe Temperature (TMAX) indicator illuminates. When this happens, fire extinguishers automatically deploy and the damaged engine automatically shuts down.

Single Engine Failure

It is possible to fly the Flanker on a single engine. Because the engines are not aligned with the aircraft's centerline, though, the offset thrust of a single engine will cause the nose to roll or yaw in the direction of the bad engine, especially at higher thrust levels. A heavy aircraft will be more difficult to control, especially with asymmetric stores. Try jettisoning unnecessary fuel and weapons. In all cases, center the slip ball using the rudder and trim the aircraft.

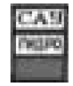
If the nose of the aircraft begins to roll uncontrollably toward the bad engine, quickly reduce power and apply more opposite rudder. For example, if the left engine dies, the aircraft may try to roll to the left. Reduce power and apply right rudder to stop the roll.

It is quite possible to land the aircraft on a single engine, but fine use of the rudder is required. The asymmetric thrust will complete alignment and you'll need to use the rudders to keep the aircraft pointed down the runway. Also remember that you only have 50% as much thrust. If you get a little too low or too slow during the approach you won't have the power available to correct the situation. Try flying a little higher than the normal approach path to give yourself more margin for error.

Dual Engine Failure

If both engines fail, the Flanker becomes a very expensive and very heavy glider. Immediately jettison all ordnance and fuel. In such circumstances, ejection is preferred over trying to ditch the aircraft; however, if you have sufficient altitude you may wish to glide back to friendly territory before ejecting . As a rule, you can generally glide one to two kilometers for each 1,000 meters of altitude. For example, a Flanker at 3,000 meters should be able to glide 3 to 6 km.

Flight Control System Failure

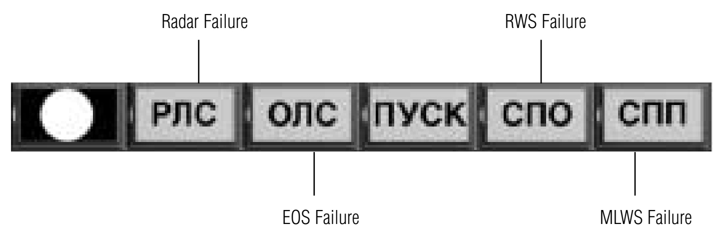


The flight control system can suffer three types of failures:

- Hydraulic System Failure – Indicated by the ГИДРО warning light, this kind of failure results in loss of control of flaperons, slats and the airbrake along with reduced aileron and rudder authority.
- Automatic Control System (ACS) Failure – Indicated by the САУ warning light, this type of failure renders the autopilot and the Altitude Stabilization mode inoperable. You must disable any automatic flight mode and assume manual control of the aircraft.
- Automatic Control Regulation System Failure – Also indicated by the САУ warning light, this failure switched the Flight Control System to "rigid link" operation. In this backup mode of operation, the FCS computer applies proportional control: moving the stick a certain percentage of total travel moves the control surfaces the same percentage of their maximum movement. The aircraft becomes very unstable at slow speeds and reacts badly to stick movements at high speeds. Disable the autopilot if necessary and assume manual flight control. Maintain forward airspeed of 500 to 600 km/hr and head for the nearest airbase. Fly the approach at 400 km/hr and touchdown at 270 km/hr.

Special Systems

Individual instruments may also be damaged. The most common items to take damage are the HUD, the MFD, the Radar, RWS, and MLWS. Most of these failures are indicated on the MWS caution lights. If any of these systems fail, they will be unusable for the remainder of the mission.



Other Failures

If the pitot head is damaged, the airspeed indicator and the barometric altimeter will display erroneous results. The ACS may be erratic, engine RPM may drop, and forward airspeed may decrease.

If the ECM system fails you will have no active jamming system for the remainder of the mission.

The Helmet Mounted Target Designation (HMTD) may also be damaged. The Targeting circle disappears and you will be unable to designate targets in Helmet mode.

CHAPTER 9
Tactics

Defense Visual Information Center - Department of Defense

STRATEGY AND TACTICS OVERVIEW

Modern technology has completely revolutionized the battlefield in less than a century. Aircraft in particular have advanced from little more than motor-powered kites to modern combat jets in just a few decades. Defense contractors and military officials often cite the strengths of their vehicles, but rarely mention the major shortcomings in public. Consequently, many people develop an opinion that aircraft (and other battlefield platforms) are more capable than they really are.

The primary reason flight simulator pilots get shot down is inappropriate usage of their platform. Keep in mind that surface-to-air defenses and enemy aircraft have made the same technological leaps. True, today's aircraft are significantly more powerful and survivable than their WWII counterparts; at the same time, enemy gunfire is much more accurate, powerful, and able to fire at longer ranges. In short, the battlefield is a more dangerous place than ever before.

UNDERSTANDING ENEMY AIR DEFENSES

Enemy air defenses, including surface-to-air missiles and anti-aircraft artillery are an integral part of the modern battlefield. Interlinked defense nets let defense sites across the battlefield communicate and share information. Pilots must possess a thorough knowledge of (and a strong respect for) such systems, or they'll find themselves riding a parachute with alarming frequency.

AAA

In general, Anti-Aircraft Artillery (AAA) is effective against low-flying targets and mainly serves for covering troops from enemy aircraft. Many armies have multi-barreled mobile AAA systems fitted with radar and a fire control system that provide effective operation in any meteorological conditions. In distinction to Ground Forces, ship-borne artillery usually has a multipurpose character and fighting against airborne targets is just one of their several functions.

An AAA shell consists of a warhead, an impact fuse that detonates at the moment of contact with the target, and a "time fuse" which detonates after a particular flight time. The target is generally destroyed by the fragments produced by the warhead on detonation.

Land-based systems, like the ZSU-23-4 Shilka (pronounced 'shil-ka') employ mutli-barreled cannons, off-road mobility, and high rate of fire. Usually equipped with its own radar, self-propelled AAA usually has some backup aiming method, such as an IR or optical seeker.

To destroy low-flying airborne targets, combat ships use multipurpose guns that can also be used against enemy ships and coastal defense. For the most part, shipborne artillery is classed as 100 to 130-mm guns (heavy caliber), 57 to 76-mm guns (medium caliber) and 20 to 40-mm guns (small caliber). All guns have a high degree of automation of aiming, loading, and firing. Automatic small-caliber (20-40 mm) anti-aircraft guns are mainly effective against low-flying aircraft and cruise missiles. Since SAMs normally have a substantial minimum range (within which airborne targets cannot be hit) ship-borne AAA is used as a short-ranged, point defense weapon. Firing around 1,000 rpm per barrel, such weapons create a nearly impenetrable cloud of metal between the target and the ship. Such 30-mm guns have an effective range of 5,000 meters; however, range is less important than rate and density of fire.

SAMs

Surface-to-air missiles (SAMs) form the backbone of the air defense network, integrating each individual search and track sensor with every unit on that network. Short-ranged, Man Portable Air Defense Systems (MANPADS) carried by infantry troops fill any gaps.

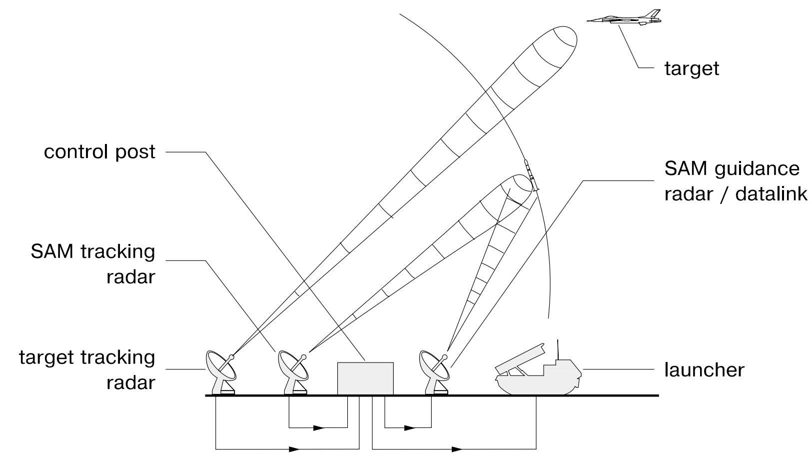
The main elements of a SAM (airframe, guidance system, fuse, warhead, and rocket motor) are similar in design and functions to those of AAMs. In addition, some SAMs utilize exhaust-deflector vanes for additional manoeuvreability.

The flight trajectory of a SAM, as well as the composition and principle of operation of the autopilot are governed by the guidance method employed. The autopilot on its own or with the help of ground facilities continuously calculates relative positions of the SAM and the target and provides commands to the control surfaces. Guidance for SAMs can be classified as one of the following: command, semi-active beam-rider guidance, homing and combined guidance.

Command guidance

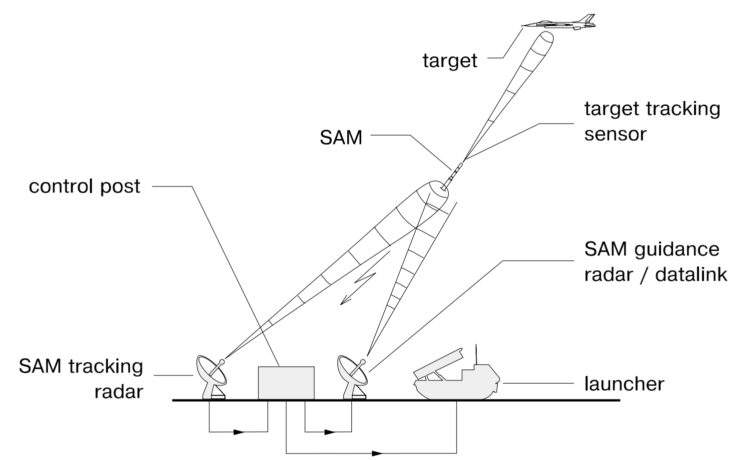
Command guidance may be compared to classic remote control. During the SAM's flight the positions of both the target and the missile are monitored from the ground or by the missile's onboard equipment.

If a SAM is guided by the ground facilities (see the figure below), the latter are responsible for detecting the target, measuring its coordinates and those of the SAM. After processing the coordinates the control post forms encoded guidance instructions and transmits them to the missile by radio data link, which is susceptible to jamming. After decoding by the missile's onboard equipment the commands are sent to the autopilot. This type of command guidance is normally employed in short-range and medium-range SAM systems (such as the SA-15 and SA-8) since the guidance accuracy decreases as the range increases.



9-x: A Typical Defense Network

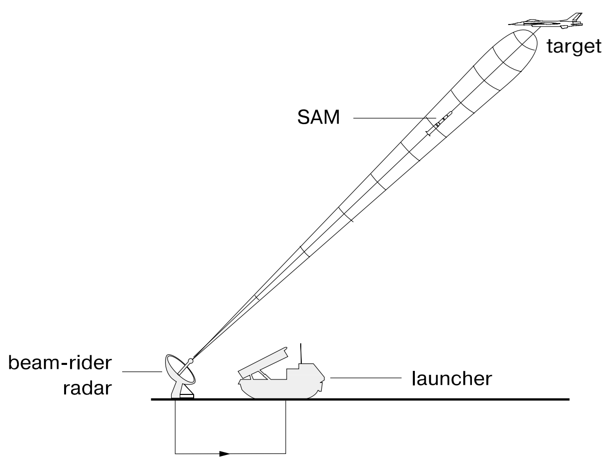
If the SAM itself can track the target, it measures and processes the parameters of the target's motion and sends them to the control post through radio data link. The coordinates of the SAM itself are measured by a ground-based tracking radar. Again, after comparing the coordinates of the SAM and of the target, the control post sends guidance commands to the SAM. Long-range SAM systems such as the S-300 (SA-10B ''Grumble') usually employ this type of command guidance in mid-course.



9-Y: Command guidance sends course updates to the missile.

Beam-rider guidance

Semi-active, beam-rider guidance is somewhat similar to command guidance along the line of sight between the target and the tracking radar, except that the missile guidance system is designed to seek and follow the center of the guidance beam automatically, without specific correction instructions from the launching platform. The guidance beam is provided by a ground-based target tracking radar, and "highlights" the direction to the target. Like command guidance systems, beam-rider SAM systems are not limited to daylight and good-weather conditions.



9-y: Beam Riding missiles follow the guidance beam to the target.

One problem with beam-rider systems, as with command ones, is that the SAM must have high manoeuvreability in order to intercept an evasive target. As they approach the target, beam-rider missiles often must tighten their turns continually to keep up. Using two radars, one for target tracking and a second for missile tracking and guidance, can reduce this problem somewhat by providing a more efficient lead trajectory. Beam-rider guidance is usually more accurate and faster-reacting than command guidance systems.

Homing

The most effective type of guidance against evasive targets is homing, when the missile guidance system gets information about the target and produces control commands on its own. Thus, the control post does not guide the SAM.

For active homing the SAM illuminates the target and receives the signals reflected off the target. In the case of semi-active homing, the source of illumination (tracking radar) is located at the control post, and the SAM receives signals reflected from the target. Passive homing systems use heat or light emitted by the target to estimate the parameters of the target's motion.

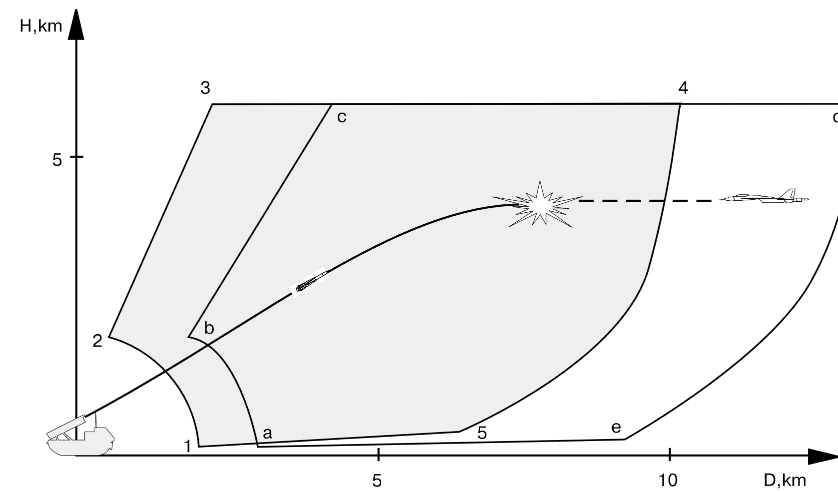
In general, homing systems operate in the following way: while the SAM rests on the launcher its seeker is locked onto the selected target, the parameters of the target's motion being measured. After launch the SAM seeker tracks the target, estimating the tracking error and produces control commands independently from the ground.

Combined guidance

As the name implies, some missiles combine guidance methods to improve performance. The Kub (Cube) SAM system (SA-6A 'Gainful') is an example of a system with combined guidance. This system employs radio command guidance on the initial part of the missile trajectory and homing when closing in on the target. This provides high accuracy at long range.

SAM engagement envelope

Like air-to-air missiles, SAMs have specific engagement envelopes. Firing at targets within the heart of the envelope increases the likelihood of a hit. Just like air-to-air missiles, the envelope varies based on the target's range, altitude, and aspect. In the engagement diagram shown, the area defined by the numbers 1, 2, 3, 4, and 5 represent the missile's effective area. Note that this envelope shifts if the target is moving toward the launcher, in the area defined as a, b, c, d, e. In this case, the missile must be fired at longer range since the target will fly part of the way into the missile. If the missile is fired too late (once the target has crossed the a, b, c line), it pass out of the envelope before the missile arrives.



Caption 9-x: Typical SAM engagement envelope.

The position of the upper and right boundaries of the envelope mainly depends on the energy capabilities of the SAM and quality of its tracking system. This boundary defines the altitude and range to the collision point providing engagement effectiveness not less than a given threshold. Since the SAM trajectory depends on target speed, altitude, and course, the position of the envelope boundary is calculated for a particular given speed of the target.

Maximum effective range of the tracking system is governed by the target's radar cross section (or effective reflection area) and altitude and varies substantially against different sized targets. If for a certain target the effective range of the radar is less than that of the SAM, this will decrease the engagement envelope. SAMs are generally classified based on their range as:

- Long-range (> 100 km).
- Medium-range (20 to 100 km).
- Medium-and-short range (10 to 20 km).
- Short-range (< 10 km).

The position of the lower boundary of the engagement envelope depends on the radar's ability to detect and track low-flying targets and on the ability of the SAM to fly at low altitude without crashing into the ground. Besides, the proximity fuse should not mistakenly detonate near the ground by confusing the latter with a target.

Many factors such as curvature of the ground surface, reflection of radio waves from the ground, and ground clutter, limit the possibility of detecting a low-flying target. Ground curvature limits the line-of-sight range, which affects operation of long-range and medium-range SAMs. Indeed, if a radar antenna is located at ground level, then the radio horizon dip is about 20 metres at a distance of 20 km and 150 metres at a distance of 50 km. The dip of the radio horizon increases proportionally with the square of distance. This means that it will be impossible to detect a target flying at an altitude of less than 150 metres while at a distance of 50 km. Lowering the radar beam will not help as it will only create further ground reflected interference which further reduces range.

The figure below shows a typical antenna radiation diagram as a function of distance and altitude.

Furthermore, at low altitudes it is relatively difficult for radar to discriminate between target returns and returns from local objects such as towers, moving heavy goods vehicles, etc. Reflection intensity of local objects may vary depending on their material, size, shape, surface smoothness, etc. Consequently, returns from local objects depend on the specific operating conditions of the radar. These returns may lead to errors of measurement of angular position and range to the target, which will adversely affect the quality of guidance and may break the target lock.

To aim a SAM at a certain point, most SAM launchers are equipped with horizontal (for azimuth angles) and vertical (for elevation angles) mechanisms. Such SAM launchers are called rotary. This makes it possible to launch the SAM in the optimal direction therewith reducing an initial vectoring error and bringing the near boundary of the SAM envelope closer. Modern SAM systems also use vertical launchers which permit simultaneous multi-direction launches.

The Defense Network

Modern military forces link their early warning and tracking radars via an interlinked network. This allows one search (or tracking) radar to share data with every other user on the same network. Consequently, the SAM launcher may not have to transmit from it's own radar, instead relying on guidance from other tracking devices located elsewhere on the net. It may appear that all enemy radar sites are located several kilometers ahead of you, but you may be directly over the enemy launcher!

"Blinking," whereby different tracking radars on the network take turns tracking the target and guiding the inbound missile is a very common practice. No one radar stays on long enough for your forces to counterattack, and the heading of the radar warning continually changes on your radar warning receiver. When caught in such a SAM trap, you must visually locate the incoming missiles, take the appropriate evasive manoeuvres described later in this chapter, and get out of the trap as quickly as possible.

COUNTERING AGAINST ENEMY AIR DEFENSES

Successfully penetrating the enemy air defense network is difficult . The following suggestions will help you punch through, engage the target, and make it safely home again.

Don't Get Shot At

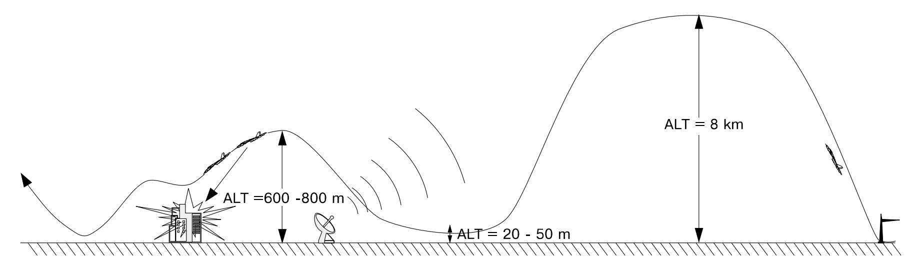
It may seem rather obvious, but the best way to avoid being hit by a missile is by preventing the enemy from ever launching one. Fighter jets are often portrayed as modern knights roaming the skies in search of a duel, but are in actuality more like cats. Skillful hunters and powerful killers, they try to slip by silent and unseen while stalking unsuspecting prey. Try to avoid enemy air defense concentrations when ever possible. If possible, flight paths should be routed toward known weak spots or other areas which have been heavily attacked.

Further, don't wander from the instructed flight path. Other aircraft and ground forces will usually be working to keep a corridor open for you. Straying out of this corridor and into enemy SAM traps is usually fatal and is a common problem for simulation pilots.

Suppresion of Enemy Air Defenses

The Su-27, being rather large, isn't particularly stealthy. The pilot, therefore, must rely on tactics to mask his presence from the enemy. Perhaps the most effective way of preventing the enemy from firing is simply to shoot first. This generally means detecting the bad guys early, making a discreet approach, firing first and getting out fast. By launching a fire-and-forget anti-radar missile, such as the Kh-31p, the targeted SAM is forced to switch off its own radar to have any chance of surviving. In air-to-ground terms, strike forces should generally be accompanied by a SEAD escort; two or more aircraft equipped to engage enemy air defenses and radar sites.

Low Level Flight



Caption: Figure 9-x: A typical hi-low-hi ingress profile.

Such a brute force, kick-them-in-the-teeth approach may not always be possible. There may not be sufficient aircraft available or the enemy may have taken out friendly GCI radars. In this case, terrain masking may be the best choice. As the name implies, pilots fly extremely low (as low as 30m above the ground in some cases) using hills, mountains, and other landscape features to

remain discreet. All tactical detection systems rely on line-of-sight between the sensor and the target. Laser, radar, optical, and IR detection and tracking systems cannot penetrate hills and other such obstacles. Such nap-of-the-earth (NOE) flight is very effective, but is also very dangerous. At high speed and low altitude, the slightest mistake can result in an immediate crash. Also, AAA units will generally be placed to protect low-level ingress routes to high-value targets, further increasing the hazards of flying low. This type of tactical flying will not be effective against modern AWACS tracking, but will keep you clear of most AAA and SAM risk.

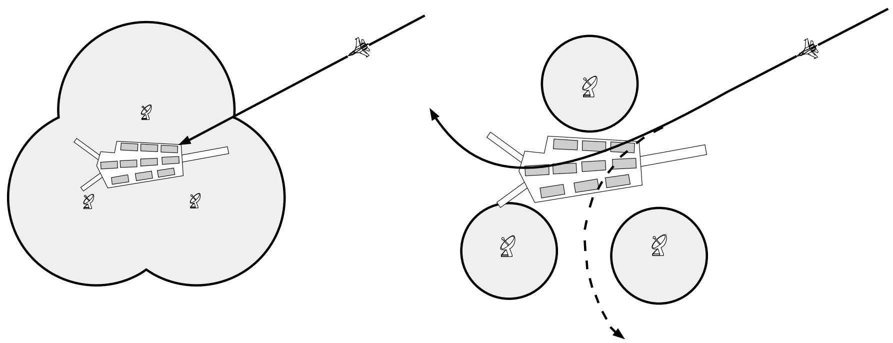


Figure 9-x: The affects of target altitude on radar propagation. Flying high (left) increases chance of detection as opposed to flying low (right).

AAA Counter Measures

AAA systems generally cannot engage targets above 1,500 meters above them. That does not necessarily mean that flying 1,501 meters above sea level renders you immune to AAA. The enemy will often place AAA on hilltops or ridgelines, thus increasing their effective altitude. Generally, the best way to evade AAA is to simply climb above it. Inside its engagement envelope, however, AAA is deadly. When AAA fire suddenly erupts around you, always remember:

1. Be unpredictable. Any erratic jinking manoeuvres will help disrupt the AAA's fire control computers.

2. Don't waste energy. Each time you pull the stick to manoeuvre you bleed energy and airspeed. Keep weaving, but don't slow down.

3. Don't fly in circles. Make your turns erratic and unpredictable. Whatever you do, keep flying along a general course that takes you away from the AAA. Don't fly circles above it.

If you're near its effective altitude limit, you might be able to engage afterburners and quickly climb above it. This, however, poses two potential problems. First, you'll present a nice, easy target while climbing. Second, by increasing altitude you increase the likelihood of being detected by other air defenses or aircraft.

Evading Missiles

Missiles are tough opponents, they are in general 2-3 times faster, can pull 3-4 times mores G than you and are small and hard to track visually. Successfully evading a missile depends on many factors such as how quickly you detect the missile and how deep you are within the weapon's launch envelope. Depending on the circumstances, you have several evasive manoeuvres to choose from; choose the wrong one and the missile, quite literally, will follow you for the rest of your simulated life.

In Chapter 6 we discussed the air-to-air missile envelope and how factors like range, airspeed, and altitude of the target and launcher impact that envelope. Fortunately (for the target aircraft), missiles are bound by the same laws of physics as the aircraft they chase. That is, despite having much more power available than aircraft, they bleed speed in a turn just like a fighter and missile turn rate and turn radius performance depend on the missile's overall energy state. The trick to defeating missiles, therefore, is making it run out of energy before it gets to you.

Launch Warnings

Launch warnings come from a variety of sources. In some circumstances, a wingman might see the launch and issue an appropriate warning over the radio. In some cases, your radar warning receiver might indicate the enemy is tracking you. In most cases, though, the best indication of an inbound missile is visual detection. When in hostile territory, constantly scan the area around you for puffs of smoke (indicating a launch) or long smoke trails which extend behind most missiles while the motor burns. Remember to scan the ground as well as the sky as these indicators may betray a SAM launch as well as an air-to-air launch.

Keep in mind that once the missile's motor burns out it will stop producing a smoke trail, so early detection is critical. Long-ranged air-to-air missiles generally climb to high altitude, then dive on the target, so be especially alert for rainbow-shaped smoke trails coming toward you!

Knowledge Is Power

Your first weapon is knowledge—knowledge about your enemy's capabilities and his position. For example, assume that an U.S.-built AMRAAM has a nominal range of 45km at 5,000m. You've conducted a thorough radar sweep of the area ahead of you and are certain that the only targets around are a pair of F-15s about 40km away. Suddenly, you see the tell-tale smoke trails of inbound missiles. Since you know these missiles were fired near maximum range, you can probably out-run them. Execute a corner-speed, turn 180 degrees away, then unload to 1g, and accelerate directly away by diving at 30-45 degrees at full afterburner.

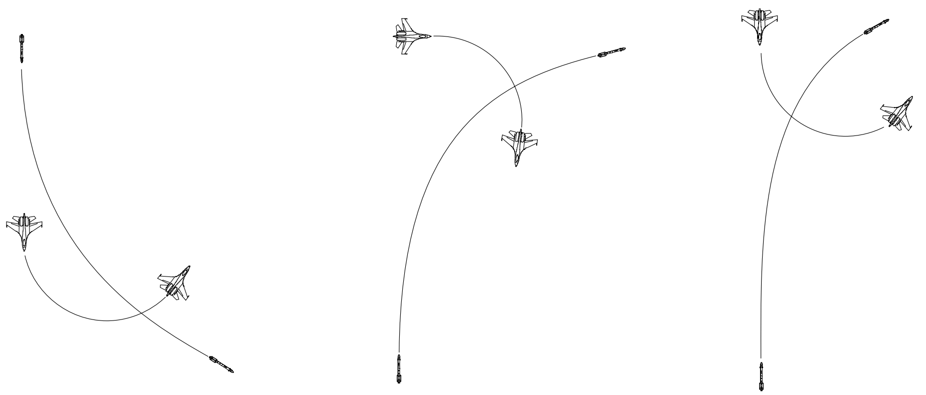
Success depends primarily on how quickly the target can turn (a clean fighter may be able to pull a 9g turn, a heavily laden jet may be limited to 5g) and how quickly it can accelerate after that turn. If you receive warning of the launch soon enough, you stand a good chance of out-running the missile. If you're late picking up the missile or the target waits until you're deep in the launch zone before firing, this method probably won't work.

Fight Missiles With Aspect

Most modern missiles fly lead as opposed to pure-pursuit paths to the target. That means each time the target changes course, the missile changes course as well. A lead-pursuit missile will attempt to hold a constant lead angle enroute to the target and appear to remain stable on your canopy relative to the horizon. A pure-pursuit missile will appear to remain pointed directly at you, but it's position will drift back toward the back of your aircraft. For the most part, if the missile appears in a relatively constant position while steadily growing larger, it's successfully tracking your aircraft. If the missile appears to be rapidly moving across your canopy, it's probably going to miss you (or is tracking somebody else).

▶ If missile appears stationary on the canopy while growing steadily larger, it is probably on intercept course. If it's rapidly moving across the canopy, it probably won't hit you.

Since missiles, like aircraft, need energy to manoeuvre and bleed speed while manoeuvreing, you want to make the missile manoeuvre as much as possible. The more you manoeuvre, the more work the missile must perform and the more energy it will bleed trying to adjust to your manoeuvres. This forces the missile to fly a curved path to the target, bleeding speed and energy along the way.



Beaming an inbound missile.

Begin by "beaming" the target; that is, executing a corner-speed, turn toward the missile to place it exactly 90 degrees off your nose (to either your 3 o'clock or 9 o'clock position). Once you have the missile directly on your 3/9 line, pull just enough g-load to keep it there. The missile has a limited field of view, much like the beam of light emitted from a flashlight. If you pull a continuous 9g turn in the middle of that "beam," the "flashlight" will fly up to, and then punch a hole through, your aircraft.

Instead, you want to fly toward the edge of the beam, known as the gimbal limit moving as fast as possible across the missile's field of view. By manoeuvreing to the edge of its field of view you force it to make the largest corrective manoeuvres. In the best case, you might move out of its field of view, in the worst case you make the missile bleed as much energy as possible. Keeping the missile directly on the 3/9 line also points your hot engine exhaust away from an IR missile's seeker. Beaming may also present problems for Doppler radar systems, although remember that you're beaming the missile, not the launching platform.

Like the aforementioned flashlight beam, the missile's field of view grows wider at longer range. Consequently, at long range you'll pull minimum g. As the missile gets closer, you increase the g-load as necessary to keep it stationary on your 3/9 line. If the missile appears to move toward your nose, you're pulling too much g and basically turning inside the missile's field of view.

▶ If the missile doesn't make constant corrective actions after you begin beaming, it probably is tracking someone else.

Be sure to release chaff and flares while maintaining this turn, especially as the missile gets closer. If you start too early, the missile will not be spoofed. Each press of the Q key release one chaff (effective against radar-guided missiles) and two flares (effective against heat-seeking missiles) from the APP-50 dispenser in the tail boom. The system releases both since pilots rarely know exactly which type of missile is approaching. These decoys may present a more attractive target in the middle of the seeker's field of view. The missile may turn toward them, allowing you to pass out of it's field of view. Modern missiles are fairly smart, though, and can often tell the difference between a quickly-decelerating bundle of chaff and your aircraft.

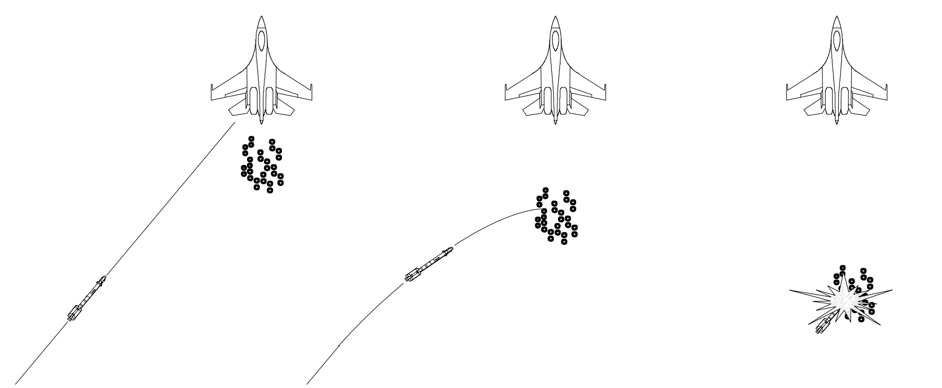


Figure 9-x How chaff/flares spoof missiles.

Flying a steady flight path followed by a high-g break turn at the last second before missile impact probably won't work. When the missile realizes it's overshooting the target, it will detonate and (depending on the missile's blast radius) seriously damage your aircraft. Instead, make the missile work all the way and give it a generous number of chaff/flare decoys to sort through.

▶ Don't fly into your own decoy. Although the decoy will drift somewhat, it remains relatively stationary compared to the speed of your jet. If you continue a steady turn after releasing chaff/flares, you'll eventually fly full circle, right back around to it. Since you're trying to spoof the missile, put as much distance between you and the decoy as possible. Also, after firing a flare, disengage afterburner if practicable. This will make the flare appear an even bright and better target than your aircraft.

Jamming

ECMActive jamming, also called Electronic Counter Measures (ECM) is designed to confuse inbound missiles by presenting them with false radar information. Jamming attempts to transmit signals in the appropriate frequency band which overpower and mask the normal radar returns reflected by the target. If the radar source closes on the target, it will eventually reach "burn through" range, at which point the reflected energy from the target is stronger than the false signals sent from its ECM gear.

The ECM gear doesn't actually make the missile go madly off into the wild blue yonder. Instead, it generally increases the distance between the missile and the target when the missile detonates. By sending false signals, the ECM gear may make the missile think it's closer than it actually is. By manipulating the frequency of the false signals, it can create false Doppler shifts, further confusing the missile.

Consequently, we can see that the jamming equipment must be specifically tuned for the threat at hand. Broadcasting high power across a wide spectrum is relatively difficult; therefore, the jamming equipment is usually configured to defeat the threats most likely to appear during a given mission. Consequently, successful jamming depends on intelligence gathering equipment to ensure the ECM gear is operating in the appropriate frequency ranges. Multiple jammers should be used if a wide variety of threats are anticipated.

Jamming has one drawback: it announces its presence to everyone for miles around. Imagine someone shouting at the top of their voice during a business meeting. The loud noise prevents other attendees from communicating but also draws attention to the screamer. Likewise, jamming may block the immediate threat, but also draws attention.

The Flanker normally carries a built-in ECM pack, providing defense against airborne and ground-based radars. The status of the jammer is indicated by the АП indicator on the instrument panel. The aircraft can also carry the Sorbtsiya-S ECM system (roughly similar to the U.S.-built AN/ALQ-135 jammer), which is installed in two pods on the aircraft wingtips. It can detect and recognize illumination sources and jam that frequency. If the enemy radar shuts down, the system automatically ceases jamming.

The Whole Package

In general, no one system (manoeuvreing, decoys, and jamming) is sufficient to spoof an incoming missile 100% of the time. Correctly combing appropriate manoeuvres with well timed decoys in a jamming environment, though, presents a formidable obstacle to inbound missiles. The key to survival, though, is early detection of enemy missiles. The earlier you see the missile, the more time you have to defeat it.

AIR-TO-AIR TACTICS

The Su-27 was built as an air superiority fighter. Despite the addition of air-to-ground ordnance (especially on the Su-33), the air-to-air is a primary part of the Flanker's mission. The main goal of air-to-air engagements usually isn't to let the situation degrade into a dogfight. Especially for interceptor aircraft like the Flanker, the goal is to engage enemy aircraft at long range before the enemy can counter attack. Ideally, the enemy aircraft are destroyed, but merely forcing them to abort their mission is often sufficient. In military terms, this latter case is called a "mission kill."

Searching For Targets

The Su-27 carries a very powerful radar, but can only provide weapons tracking information against one target at a time. The Su-33, however, can provide weapon targeting and launch solutions for two targets simultaneously. Ideally, long-ranged counter-air missions should always include AWACS support. With AWACS information datalinked directly to the Flanker, enemy aircraft will be painted on the MFD even if the Flanker's radar is inactive. Keeping the Flanker's radar deactivated reduces the chances of being detected by enemy aircraft (remember, enemy aircraft can detect your radar transmissions about two times farther away than the your radar can detect that aircraft). Use AWACS data (or other datalinked radar information) to trap or ambush the enemy.

If AWACS isn't available, then the aircraft assigned to the mission must conduct their own air searches. Keeping in mind the limitations of the scan cone, flight leaders should order formations that allow effective searches of wide areas. Two aircraft flying close, finger-tip formation effectively limits both aircraft.. Horizontal separation lets two aircraft search a wider area; vertical separation lets them search a taller area.

Vertical and horizontal spacing also complicates the enemy's ability to track and detect friendly aircraft. Enemy search radars on fighter aircraft also have limited scan cones. Widely spacing friendly aircraft may keep some of them outside the enemy scan cone. Further, this aircraft is free to manoeuvre while the enemy focuses attention on the detected aircraft. The second aircraft can manoeuvre around and engage the enemy from its flank or rear while the first aircraft lures the enemy fighters into the trap.

When forced to conduct your own long-ranged searches, keep in mind that the radar cross section (RCS) of the target determines how far away the Flanker's radar will detect it. Large bombers will generally be detected much farther away than tactical aircraft. Also, ground clutter generally helps mask targets. Consequently, lower-altitude targets usually can't be detected at longer ranges.

Manoeuvres

While the goal of any interceptor is to engage with long-ranged missiles and escape, dogfights inevitably erupt.

▶ Air combat is not a chess game. Pilots do not use specific manoeuvres to

"counter" enemy movements. Air combat is a fluid, dynamic, constantly changing environment. Rather than thinking "he did a split-S, so I'll counter with a high yo-yo," pilots instead consider where they need to point their aircraft in order to employ their weapons. They then execute the appropriate manoeuvre to adjust their lift vector and bring their aircraft into a firing position.

The Break Turn

The most basic, defensive manoeuvre is the break turn. In this case, the pilot turns toward the threat aircraft to increase aspect angle and ruin the opponent's firing solution. Generally speaking, a break turn indicates a maximum-performance turn, using all available instantaneous g.

As an attacker, if the target executes a defensive break turn, you will generally resort to the high yo-yo to prevent overshooting.

The High Yo-Yo

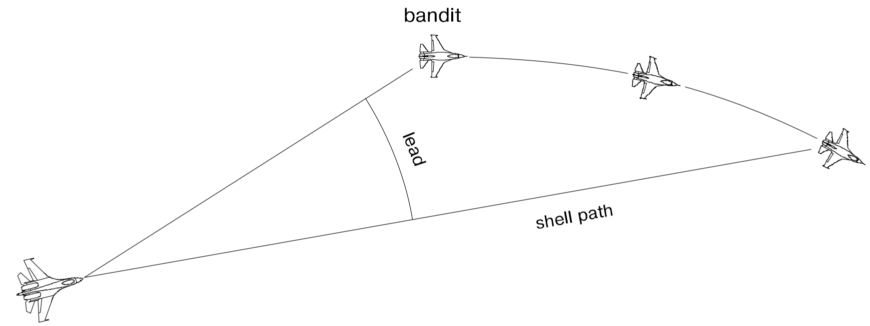
The high yo-yo uses a relatively quick movement out of the target's plane of motion to either slow closure rate or to reduce aspect angle to the target. The high yo-yo is performed by rolling slightly behind and above the target,extending behind the target's flight path for a moment, then rolling back toward and pulling the nose down to the target. The high yo-yo generally increases the range to the target, but decreases the aspect angle, setting up an firing opportunity. The length of time between rolling away from the target until pulling back into the target determines how "big" the yo-yo is. Generally speaking, executing a series of small yo-yo's to slowly nibble away at a large angular problem is better than executing one large manoeuvre.

If you have an adversary executing high yo-yo's behind you in order to gain a firing position, watch the enemy's nose closely. Your movement away from him helps solve his closure rate or aspect angle problem. Whenever his nose comes off (that is, is pointed behind your flight path), relax your turn and accelerate, thus increasing your energy status. As his nose pulls back into firing position, increase the g-load and tighten your turn. Conserve your energy when his nose is off, spend your energy as he brings his nose toward a firing position.

Aerial Gunnery

Firing a gun from a moving platform and trying to hit another moving platform executing evasive manoeuvres is no trivial task. To begin with, the bullets take a finite amount of time to leave the barrel and travel to the target; the further away the target is the longer each projectile takes to cover the distance. During that time of flight, the target will probably execute some form of evasive manoeuvre; he probably won't be in the projectile's flight path by the time it gets there. So, the shooter has to "lead" the target; predict where it will be by the time the bullets get there and then fire at that point hoping the target flies into the projectile stream. Meanwhile, gravity tugs on the projectiles, pulling them toward the ground. The farther and slower the projectile flies, the more the bullets drop. The shooter must factor this drop into the lead calculations as well.

Meanwhile, the shooter is moving also. Since he's chasing the target, he's probably flying a curved flight path. Consequently, his tracer stream appears to "bend" away since the individual rounds continue on a straight flight path. If all goes according to plan, the shooter aims ahead of the target, fires, and watches the tracers appear to fly a curved path to intercept the target.



Based on this scenario, we see that the range to the target is arguably the most important aspect of aerial gunnery. The further away the target is, the longer the bullets fly. Consequently, the shooter must lead the target more and account for greater drop due to gravity. As most WWII pilots (who did not have the benefit of pickling off a guided missile) discovered, don't shoot until the enemy aircraft fills the view. The closer you are, the more likely you'll hit something. Deflection shooting, or the art of appropriate leading a manoeuvreing target, increases in difficulty as range to target increases.

▶ **Aerial gunnery can be summarized in three steps:**

1. Match the target's wings.
2. Pull lead.
3. Shoot

Tracking Shots vs Shots of Opportunity

A tracking shot refers to a relatively slow, methodical approach to the target, achieving a stabilized firing position, and shooting the target. The shot of opportunity, on the other hand, refers to the brief moment when a target aircraft suddenly (and perhaps unpredictably) crosses your nose. You have mere moments to react, but a quick burst of gunfire is likely to score hit if fired in time.

Whereas opportunity shots rely primarily on your reflexes; tracking shots require more finesse. In particular, you generally need to be in the same two-dimensional plane of motion as the target. This is defined by two vectors, the forward velocity (or longitudinal axis) and the lift vector (which is perpendicular to the wings). Although a good deflection shooter, especially equipped with a

modern HUD and “shoot” cues, may be able to achieve the appropriate lead, but manoeuvreing in-plane with the target aircraft greatly increases your chances of scoring a hit.

How do you manoeuvre into the target’s plane of motion? By matching the target’s wings. You can obtain a high-percentage tracking shot by manoeuvreing behind the target, matching the bank angle of the target’s wings, then pulling sufficient lead based on the range to the target. When executed properly, the target should fly straight into the “bending” stream of your tracers.

Using Air-to-Air Missiles

Air-to-Air missiles are relatively easy to use. Once you’ve locked a target, select the desired weapon. If the target is within acceptable launch parameters, the ПР (LA) “shoot” cue will appear on the bottom of the HUD. Firing a missile at a target near the missile’s maximum range greatly reduces the chances of hitting; the less distance the missile has to fly the greater the chance of it hitting the target. When the target is within range and the “shoot” cue is displayed, release the weapon.

Remember that SARH missiles require a continuous radar lock for the duration of the missile flight. If using SARH missiles, be careful to maintain radar lock until the missile reaches its target.

AIR-TO-GROUND

The methods of using air-to-ground weapons greatly depend on their type. However, there are some common ways of interpreting the commands of the Weapons Control System and using weapons against ground or water surface targets:

1. Make sure that the Weapons Control System and the HUD are in the A2G Mode as shown by the ЗЕМЛЯ designation on the HUD Mode Indicator (if not, press **7**).
2. Choose optimal weapons for the planned target by cycling through onboard weapons (press the **D** key). To toggle the cannon, hit the C key. The selected type of weapon and its remaining quantity will be shown on the lower part of the HUD. The Weapon Readiness Panel illuminates the pylons carrying the selected weapon.
3. Place the Aiming Reticle on the visual target or the cross-hairs on the target’s image on the MFD by manoeuvreing your aircraft.
4. After you place the target in the sight, lock onto it to provide targeting information for the selected weapon or just fire (depending on the weapon used).
5. Select Salvo mode if you want to fire unguided rockets from all available pods or release all bombs simultaneously. To toggle Salvo mode, use the **Ctrl+V** keys. If this mode is active the weapons type and quantity symbology on the HUD are enclosed in a rectangle.
6. If the selected weapon requires that specific conditions for range or other parameters should be met, you have to wait until the ПР Shoot Cue appears on the HUD and only then start firing.

Missile Guidance Techniques

The Su-33 can use a wide variety of air-to-surface missiles, including antiship (Kh-31a, Kh-41, Kh-35), tactical (Kh-29te, Kh-59m) and antiradar (Kh–31p). The missiles have different guidance systems and interact with the WCS and radar in different ways.

In the first case the radar enters all the initial information about the target (coordinates, speed, etc.) into the missile’s guidance system prior to launch. This method is commonly used with fire-and-forget antiship missiles equipped with sophisticated inertial + active radar combined guidance systems (Kh-41, Kh-35, Kh-31a). After the launch, the missile flies to the vicinity of the initial coordinates, switches on its onboard seeker, and searches for the target.

The second guidance method is called “command guidance.” The Kh-59m, for example, uses command guidance. Prior to launch, the radar locks on to a specific ground target. After the missile is launched, the radar transmits guidance commands to the missile, steering it to the target. This system is relatively inexpensive and is very effective against stationary targets. Of course, the launching aircraft must maintain a radar lock on the ground target until the missile strikes. This could leave the launching aircraft vulnerable to counter attack.

Passive guidance systems comprise the third guidance type, encompassing several types of missiles. Whereas command guided missiles receive specific course instructions, passively guided missiles home in either on the emissions produced by the target (heat, or radar) or by energy (light) reflected by the target. The Kh-29te, for example, uses either IR (heat) or TV (light) tracking systems, homing in on the energy emitted by (or reflected from) the target. The Kh-31p, meanwhile, homes in on radar energy emitted by the target. Such systems do not rely on the Flanker’s onboard radar for guidance, but the individual missile’s seeker , to search for, to select and to engage targets.

TYPE OF MISSILE	MISSION	GUIDANCE SYSTEM	THE MISSILE GUIDANCE SYSTEM GETS INITIAL DATA FROM:	“FIRE-AND-FORGET”
Kh-35, Kh-31a, Kh-41	Antiship	Inertial + active radar	Flanker Radar	YES (for all three)
Kh-31p	Antiship, antiradar	Passive radar	Missile Seeker	YES
Kh-29te	Pinpoint strike, Antiship	IR (or TV)	Missile Seeker	YES
Kh-59m	Pinpoint strtike	Command	Flanker Radar	NO

Using tactical missiles.

Su-33 can carry two tactical missiles: Kh-29te with IR or TV seeker, effective against fortifications, major railway and highway bridges, launchers, ships, surfaced submarines, etc. and Kh-59m long-range tactical missile with command guidance system, which can be used against static ground objects (buildings, bridges, etc.).

Kh-29te

After selecting the Kh-29, the MFD displays information supplied by either the missile’s onboard seeker or, if selected,the aircraft’s radar. While it may be useful to use the radar to initially locate your target, you should always disable the radar and ensure the missile’s onboard seeker is tracking the target before launching the weapon.

The Kh-29 Aiming Reticle

When using the Kh-29te, an aiming reticle appears in the HUD, indicating where the missile's onboard seeker is looking. Steering the seeker head with the scan zone controls moves the aiming reticle around the HUD. The MFD displays the view seen by the missile's seeker. The seeker provides three levels of magnification, 2x, 8x, and 32x. Adjust the magnification displayed on the MFD up and down using the + and – keys.

Comparing MFD Magnifications: 2x, 8x, and 32x.

By steering the seeker and manoeuvreing your aircraft, place the aiming reticle over the target. Increase magnification, if necessary, to help identify the target. Lock the seeker to the object by pressing TAB. The MFD view now stays focused on the locked object and the aiming reticle tracks the object's position. You may lock the target using any magnification level. To break the lock, press the TAB key again.

HUD Symbology For A Locked Kh-29te

The HUD now shows a range-to-target scale along the left hand side as well as the missile's time-of-flight along the lower edge. When you've manoeuvreed within the missile's launch envelope, the HUD displays the launch indicator. Try to move the aiming reticle near the center of the HUD before firing the missile. This helps ensure the missile will not lose the lock on the target. Once the missile is released you're free to manoeuvre and/or engage other targets.

Kh-59m

Functionally, using the Kh-59m is similar to firing a Kh-29te. The Kh-59, however, uses command guidance meaning:

1. You must use the Flanker's radar to locate and lock the target
2. You must not break the radar lock until the missile strikes the target.

Begin the process by activating the ground radar. Using scan mode, SWA mode, and SNA mode, locate the desired target. Lock the target by pressing **TAB**. Manoeuvre toward the target until the shoot cue appears, then launch the missile. The autotrack indicator will begin flashing, denoting you have a missile inflight under data transmission guidance. Maintain the radar lock until the missile hits.

Kh-59m Symbology

Using Antiship Missiles

Antiship missiles receive their initial guidance information from the Flanker's radar. After radar locking a target, the weapon system downloads the coordinates of the target to the missile. When launched, the missile flies to the vicinity of the target, activates its onboard radar, and searches for the target. Antiship missiles carried by the Flanker are all fire-and-forget meaning once the missile leaves the pylon, you're free to manoeuvre and/or engage other targets.

To fire an antiship missile you must first locate it on the ground radar. Locate a ship using the scan, SWA, and SNA radar modes. Lock the target by pressing the **TAB** key. Manoeuvre toward the target until the shoot cue appears, then launch the missile. The radar will immediately drop the lock and you're free to manoeuvre or engage other targets.

Anitship Missile Symbology

Using Antiradar Missiles.

Antiradar missiles home in on the radar emissions of ground and sea-based transmitters, such as early warning radars, SAM guidance radars, and air traffic control radars. The Kh-31p antiradar missile can engage all types of SAM radar systems without requiring the launching aircraft to enter the SAMs launch zone.

Target detection begins with the SPO-15 RWS detecting an emission source. This system illuminates the appropriate lights on the TWD, trips the master warning. Steer the aircraft to bring the desired target directly ahead of your nose. Lock the target by pressing **TAB**. Manoeuvre toward the target (fly toward the marker on the HUD) until the shoot cue appears. After firing, the weapon system drops the lock and you're free to manoeuvre and/or engage other targets.

After locking the missile to the radar emitter, the HUD switches to autotrack mode, displaying the usual information on range and missile flight time.

Antiradar HUD Symbology

The Kh-31p is launched when it is comfortable with the strength of the radar signal from the emitting vehicle. As the missile flies towards the target, it sharpens the exact location of the target, giving it the possibility to calculate the target's ground coordinates. This means that should the target radar be switched off prior to impact, the Kh-31p would still have a chance of hitting the target.

If the range to the target is less than the Kh-31p's minimum launch range, the reject cue appears on the HUD and the you cannot fire the missile.

Firing Unguided Rockets and The Cannon

You may engage ground targets with unguided rockets or the onboard cannon. Both weapons are relatively short ranged and less accurate than tactical missiles. Begin the attack by switching to air-to-ground mode and selecting the desired weapon. Using scan, SWA, and SNA radar modes, locate the desired target and lock it by pressing **TAB**. The diamond-shaped target designator appears in the HUD, showing the position of the locked target.

By manoeuvreing the aircraft, place the aiming reticle directly over the target designator. If you are within the weapon's minimum and maximum launch ranges, the shoot cue appears. If you are outside of the weapon's effective range, the reject cue appears. When using the cannon, it fires 25 rounds per salvo.

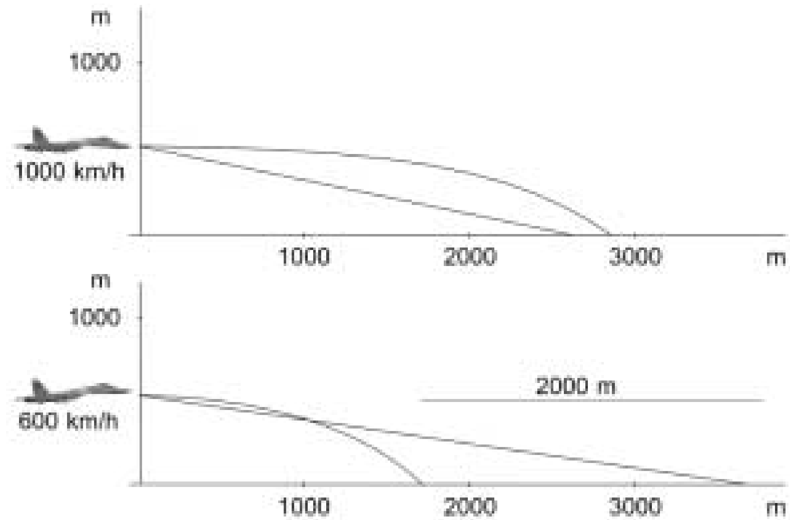
Firing Unguided Rockets

Note that you can fire both the cannon and rockets without radar locking a target. Simply place the aiming reticle over the desired location and fire.

Dropping unguided bombs.

Unguided bombs are traditional weapons effective against enemy fortification and military plants, railway junctions, and soft targets such as personnel and light armored vehicles. Typical bombing altitudes range from 300 to 1500 meters with typical airspeeds from 500 to 1000 km/h. Note also that unguided bombs are usually dropped in pairs to prevent not unbalancing the aircraft.

You can select the target either visually or by using the radar. While using these weapons, the main task of the WCS is to calculate the Continuously Computed Impact Point (CCIP) and time remaining to the bomb release and project this information on the HUD. Your task consists in placing the CCIP Pipper on the target (or over the diamond-shaped Target Designator). Since the course of an unguided bomb can be corrected to some degree (prior to release), the HUD displays minimum and maximum release ranges for unguided bombs. Manoeuvre the aircraft to place the CCIP pipper over the target.



Effects of Release Speed on Bomb Range

Immediate Release

If the shoot cue is displayed, you can pull the trigger. This indicates that the position of the CCIP pipper is within the bomb's drop envelope. This releases the bombs immediately, and they will hit the point designated by the Pipper.

Immediate Bomb Release HUD Symbology

Aeronautical Mode

If the location of the CCIP pipper is outside of the bomb's flight envelope, the shoot cue will not appear and you can not immediately release the weapon. In this case, pressing the trigger will engage the Aeronautical Mode. letting the onboard computer decide when to drop the weapon.

The CCIP pipper is replaced by the aiming reticle. Keep the aiming reticle aligned in the center of the HUD. When you pull the trigger, the onboard computer calculates the ideal release point and displays a time-to-release counter in the lower right corner of the HUD. You may release the trigger now, but you must depress and hold the trigger as the countdown nears zero. If the trigger is pressed when the countdown reaches zero, the computer will automatically release the bomb.

Aeronautical Mode HUD Symbology

If you wish to cancel the countdown, press Tab. If the trigger is not depressed when the counter expires, the weapon system automatically switches out of Aeronautical Mode.

Dropping guided bombs

A guided bomb is a free-fall bomb equipped with some sort of guidance system (usually TV or laser) that can make some corrections to the bomb's flight path. When selected, the aiming reticle appears in the HUD indicating where the bomb's seeker is focused. Disable the radar and steer the bomb's onboard seeker using the scan zone controls. When you've placed the bomb's crosshairs (in the MFD) or the aiming reticle (in the HUD) over the target, lock onto it by pressing Tab. After a few seconds, the Weapon Readiness Panel should indicate the bomb is ready.

Guided Bomb HUD Symbology

Manoeuvre the aiming reticle to the center of the HUD and wait for the shoot cue to appear. Holding the trigger prior to the shoot cue appearing ensures that the bomb will be released as soon as the cue does appear.

CHAPTER 10
Crimea

WHY CRIMEA?

The Flanker version you have bought introduces the Crimea as the theatre of play. For many centuries this small peninsula on the Black Sea has been a focus of interest, and its past and present political situation are the main reasons why we have chosen it as the combat zone. The geography of the Crimea is also well suited for flight simulation. Firstly, as a peninsula it has natural boundaries, secondly, the geographical characteristics of the Crimea - steppes, mountains, lakes, and sea ensure diversity and ease of orientation.

Fortunately, war has not touched this picturesque territory too recently. All you will see in the program and take part in is nothing more than fiction that, we hope, will never become reality. But who knows.

10-14: Crimean Peninsula

Geography

In the north the Crimea is connected with the Kharkov Region by the Perekop isthmus. The Kerch strait connecting the Black Sea and the Sea of Azov separates the Crimea from Russia. Sivash - a series of shallow gulfs separated from the sea by a lowland sand spit - stretches along the whole of the north-eastern coast.

The northern part of the peninsula is a plain covered by steppe; the southern part is occupied by the Crimea Mountains that stretch from Sevastopol to Feodosia and consist of three parallel ridges with gentle northern and steep southern slopes. The highest point of the Crimea is the Roman-Kosh mountain (1545 metres) situated to the north-east of Yalta.

The Crimea is blessed with a Mediterranean climate. The rivers of the Crimea are shallow. It also has some large salt estuary lakes. The upper part of the peninsula has a system of canals.

The capital of the Crimea is Simferopol which has a population of 350,000. The main towns of the peninsula are Sevastopol, Kerch, Dzhankoy, Yalta, Yevpatoriya, and Feodosiya. The Crimea is the favourite recreation place of Russian and Ukraine leaders and heads of state. In 1991 during the coup initiated by the supporters of the communist regime Michael Gorbachev, the president of the late USSR, was blockaded at his dacha in Foros in the south extremity of the Crimea.

Historical background

The most ancient artefacts found in the Crimea date from the Palaeolithic period. A Scythian State arose in the steppe part of the Crimea in the third century BC. All subsequent history of the Crimea is a history of wars.

In the 3-4th centuries A.D. Goths and Huns seized the Crimea and founded the Tmutarakhan Principality. In the thirteenth century A.D. Mongol-Tatars invaded the peninsula and founded the Crimean Ulus of the Golden Horde. After the Golden Horde had collapsed in 1443, the Crimea Khanate arose and remained in existence for about 300 years as a vassal of Turkey. During all those centuries the Russians and Ukrainians fought side by side against the Tatar and Turkish raids.

As a result of the long war between Russia and Turkey the Crimea was made a part of Russia in 1783. During the “Crimean War” that lasted from 1853 to 1856 Russia waged war with Turkey, England and France and was badly defeated. But the peninsula remained in Russian hands.

The territory of the Crimea was also an arena of military operations during the Civil War in Russia (1918) and WW II (1941-1945). The Crimean Conference of the heads of 3 allied states - victors in WW II took place in Yalta in 1945. Josef Stalin represented Russia; Franklin Roosevelt represented the USA; and Winston Churchill represented Great Britain.

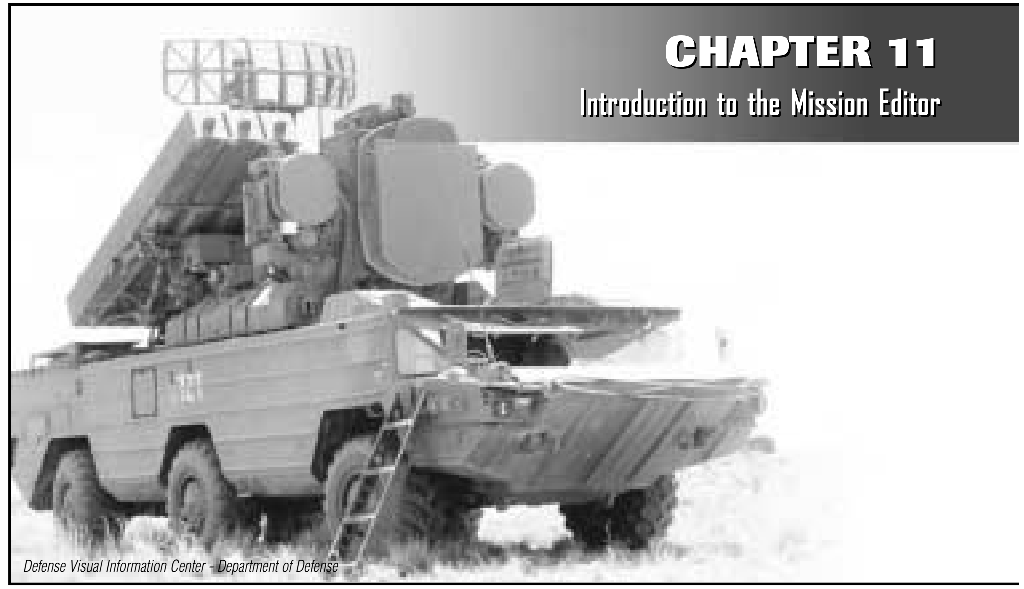
In 1954 Khruschev transferred the Crimean Region as a gift from Russia to the Ukraine. When the USSR collapsed and the Commonwealth of Independent States (CIS) was formed in 1991, the Crimea remained technically part of the Ukraine.

At present, the most acute problem that may result in an escalation from a political conflict to a military one is the problem of the Black Sea Fleet. The main reason of disagreement is the fact that after the collapse of the USSR both the Ukraine and Russia made claims to the Black Sea Fleet although historically the Fleet was always Russian. Furthermore, the main naval base of the Black Sea Fleet is Sevastopol and many other military installations of the late USSR on which Russia is making claims have turned out to be on the Ukrainian territory.

To solve the problem of the Black Sea Fleet, Russia carried out several rounds of negotiations with the Ukraine from April 1992 to May 1993. Finally, on June 9, 1995 the two countries signed an agreement, under which the Ukraine recognised Sevastopol as a naval base of the Russian Black Sea Fleet. Furthermore, Russia received 81.7% and the Ukraine got 18.3% of the ships and vessels of the Black Sea Fleet. However, the agreement did not decide the legal status and the conditions of stay of the Russian Black Sea Fleet in the Crimea.

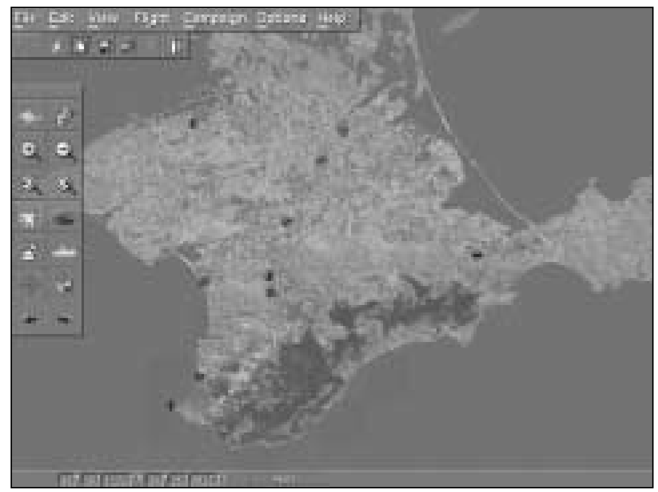
The process of negotiations between Russia and Ukraine is being further complicated by general political tension in the peninsula. The Russians making up the majority of the Crimean population are striving for independence from the Ukraine and for reunification with Russia. The population of the Crimea has formed its own government actively opposing the politics of the Ukraine. The overwhelming majority of the population is striving to get Russian citizenship. Conflicts on inter-ethnical grounds have arisen between the Russians, Ukrainians, and Tatars forcing Kiev to bring in special units from the Ministry for Internal Affairs.

In March 1995 the Ukrainian Parliament abolished the institution of presidency and the Constitution of the Crimean Republic that resulted in recurrent aggravation of the political situation in this region.



CHAPTER 11
Introduction to the Mission Editor

Defense Visual Information Center - Department of Defense



11-1: The Mission Editor Screen

INTRODUCTION TO THE MISSION EDITOR

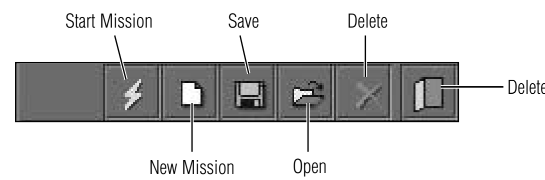
The mission editor is the heart and soul of Flanker 2.0. This is where almost everything happens. You can build mission and campaigns here. You can start multi-player games here. You can edit mission and track files.

The different menus will be discussed first and then instructions on how to build missions and campaigns will be displayed later in this chapter.

MENUS

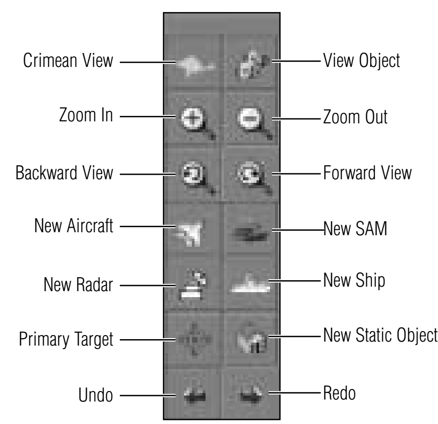
MENU	MENU ITEM	HOT KEY	MEANING
File	New Mission	Ctrl+N	Create a new mission
	Open Mission	Ctrl+O	Open an existing mission
	Save	Ctrl+A	Save the active mission to disk
	Save As		Save the mission under another name
	Exit	Alt+X	Quit the program
Edit	Undo	Ctrl+Z	Undo the last editing change
	Redo	Ctrl+Y	Re-install the last edit cleared with the Undo command.
	Delete	DEL	Delete the current selection on the map
	Classify Mission		Assign the active mission to a class and protect it with a password
	Declassify Mission		Declassify the active mission to have access to all mission resources; password will be required
View	Hide Objects	Ctrl+H	Hide or show specific objects on the map
	Crimean View	Ctrl+1	Return the map to the default magnification level around the Crimean peninsula.
	Zoom In		Magnify the map by a factor of 2 or in the dragged box
	Zoom Out		Scale the map down by a factor of 2
	Object View		When a unit is selected, this will take the view down to a very close level.
	Region View		Magnify the map to a regional view, centered on the selected object.
Flight	Briefing	Ctrl+B	View/edit the mission briefing
	Debriefing	Ctrl+D	View a debriefing when a saved misson is the loaded.
	Choose Phase		Choose the phase in a loaded campaign.
	Start Mission	Ctrl+F	Start the current mission
	Network Play	Ctrl+L	Begin a network multi-player session.
	Chat	Ctrl+M	Chat with other players during a multi-player session.
	Record Track	Ctrl+R	Start the mission and record a video sequence
	Play Track		Playback the last recorded video sequence
	Video Edit	Ctrl+V	Start the video sequence and enable its editing
Campaign	Phases		Create and edit the phases within a campaign
	Mission Conditions		Set the mission conditions within a phase
	Contingency Planning		Review all of the units in campaign.
	Remove Objects	Alt+Z	Remove an object from a condition set in a phase.
Options	Failures		Specify failures that may happen to your aircraft for training purposes
	Skills		Set skill levels for all automatic objects; specify your aircraft's survivability
	Met Report		Specify meteorological conditions (wind, temperature, cloudiness, etc.) for the active mission
	Colours		Change the colour of the icons in the Editor and the AWACS view.
Help	About Su-27 Flanker		Show the program info, version number and copyright notice

Standard Toolbar



11-2: The Standard Toolbar

Beneath the Menu Bar is the Standard Toolbar, which contains a set of standard buttons, typical to many windows applications.



11-3: The Planning Toolbar

Planning Toolbar

The Planning Toolbar down the left-hand side contains buttons for scaling the map, placing aircraft, ships, SAMs, radars, and other objects.

The buttons provide you with quick pictorial access to the Mission Editor commands, many of which are duplicated in the menus. Note that you can move the toolbars to wherever you see fit.

11-4: Status Bar

Status Bar

Along the bottom of the program window runs the Status Bar, which shows information on the Mission Editor mode, the current geographical coordinates of the mouse pointer, and a short help line on the selected Toolbar button or menu command.

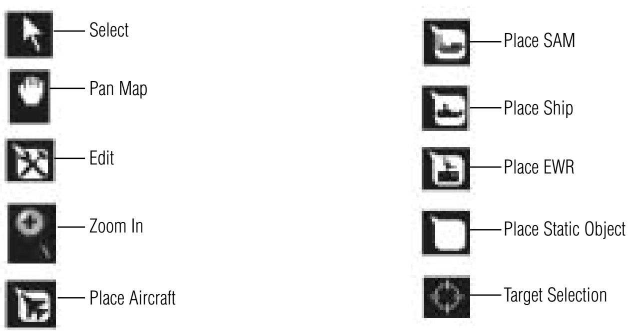
WORKING WITH THE MAP

When working in the Mission Editor, you will be required to intensively use the map for identifying targets, planning routes and placing objects. While using the map, you can:

- scroll the map in any direction
- zoom the map on the screen in or out
- grid coordinate.

Cursor States

You mouse cursor changes states depending upon the mode it is in. The following are some of the cursor states:



11-5: Cursor States

Panning

If you are interested in a particular area, which is beyond what's on screen you can shift the map in the desired direction. You can do this by simply holding down your left mouse button (which will change to the Pan state) when the cursor is in the Select or Edit state and move the map in the desired direction.

Zooming

If you are interested in details of a given area on the map or want to have a look at the entire theatre of play, change the map scale by zooming in or out.

To zoom in

1. Click on the Zoom In button on the Planning Toolbar or select Zoom from the mouse right click menu

2. Do one of the following:

- To scale the map up by a factor of two, click the left mouse button in the center of the map area you want to enlarge.
- To enlarge a given area to the size of the map window, select a rectangular region on the map by pressing the left mouse button to anchor one corner of the area and then dragging the mouse pointer. The stretching Rubber Rectangle shows the region being selected. Release the mouse button to complete zooming.

Note that Zoom In mode remains active until disabled, so you can apply zooming in repeatedly. To disable, "unpress" the Zoom In button, click on it with the mouse or click the right mouse button anywhere on the map.

To zoom out by a factor of 2

- Click on the Zoom Out button.

To view the Crimean theatre of play

- Click on the Crimean View button or press Ctrl+1.

To restore the previous map scale

- Click the Backward View button.

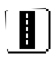
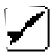
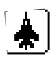
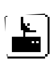
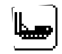
You can apply this command repeatedly to restore any map scale applied in the current session.

WORKING WITH OBJECTS

When planning existing missions or building new ones, you will be placing aircraft, ships, SAM systems, possibly static objects and designing aircraft routes. In our terminology, all the above are objects. Some of them are active objects (ships, aircraft, radars, SAM systems), whereas other objects are static (automobiles, tanks, fuel trucks...). Active objects have particular levels of artificial intelligence and behavior; they are marked by an individual symbol irrespective of the current map scale. You can place static objects in an arbitrary or specific way. For example, increasing the number of aircraft parked on an airfield makes it a more interesting ground target.

A special case is a SAM system, which consist of several units operating as a functional entity. For example, a standard S-300PMU Grumble system consists of one surveillance radar, one engagement radar and up to 6 launchers, each of them on a separate chassis. In similar cases all units comprising a system are marked by individual symbols on the map.

The table below contains a list of all symbols used on the map.

	airfield
	take-off waypoint
	landing waypoint
	Ground Alert Intercept station. This is the only waypoint of the GAI sortie
●	turning point of an unselected route. Such a waypoint is always displayed in the colour of the country owning the aircraft
3	turning point of the selected route. The number indicates the waypoint's ordinal number (from 0 to 15).
▲	action point of an unselected route. An action point implies a particular action associated with this waypoint (rocket attack point, start of a CAP station)
△ 2	action point of the selected route. The number indicates the waypoint order number.
	ship
	Early Warning Radar station
	tracking radar of a SAM system
	search radar of a SAM system
	SAM launcher
	AAA or SAM system housing both radar and launcher/guns
	portable SAM launcher (Igla)
	static object
	primary target

11-6: Editor symbols

When working with objects on the map you can:

- Select a single object or a group of objects;
- Move or delete a group of objects;
- Hide or show objects;
- Undo editing changes.

Note, however, that the Mission Editor is not a graphical editor as it may seem to be. That is why some features typical to a graphical editor may be different in the Mission Editor or not implemented at all.

Selecting objects

To select objects on the map, you should first make sure that none of the special map modes (zooming)

and the modes for placing new objects are active. This will be witnessed by the absence of sunken button on the Planning Toolbar and the cursor state.

To select an individual object, click it with the left mouse button. The selected object will be highlighted by the selection colour (by default, yellow), and the corresponding dialog box describing the object's properties (for example, a country to which it belongs, object type, orientation, skill level, and so on) will appear on screen.

To select an aircraft and its route, click on any of its waypoints. In so doing, all the waypoints enlarge and display their ordinal number on the route (from 0 to 15). Furthermore, the current waypoint and the legs of the selected route turn to yellow.

After selecting a unit you can invoke a shortcut menu, by pressing the right mouse button. This menu which lists operations available for the object. A typical shortcut menu is shown below.

While planning a mission, you might want to move a group of objects the same distance or delete them. To include an object into a group, click it while holding down the Control key.

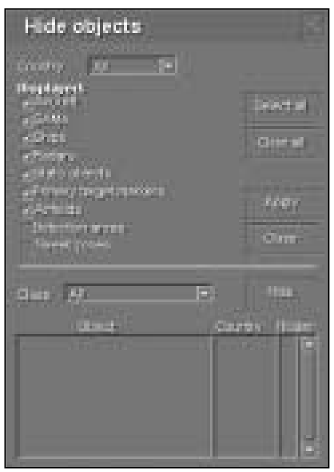
If you need to unselect an individual object, click the left mouse button anywhere on the map off objects or select another object. To exclude an object from a group, select it again with the Control key held down.

Moving and deleting objects

To move a single object or a group of selected objects, place the mouse pointer on this object or any object in the group, hold down the left mouse button and drag the object or the entire group to the new place on the map. Then release the button.

To delete a selected object/group of objects, click the Delete button on the Standard Toolbar, or press the Delete key. When you delete waypoints (using the Delete button in the Airgroup Planning menu), the remaining waypoints of the route will be automatically renumbered.

Hiding objects



If you think that the map shows too many symbols of objects, making it difficult to plan a mission or understand a combat situation, you can temporarily hide those symbols which are of no interest to you at that moment. You can do this with an individually selected object or a group of objects or you can use a specially formulated criterion, for example, hide all enemy ships.

To hide an individual object or a group of selected objects choose Hide from the shortcut menu or. The symbols of the selected objects will disappear from the map together with the objects they label. Note, that if you try to hide any waypoint of a route, this leads to hiding the entire route.

Activate the Hide Object dialog box from the View menu or by pressing Ctrl+H. Hide objects by unchecking the object type, and show them by checking.

Use the Side field for selecting the side whose objects you want to hide or show, for example, Russia or Ukraine. You can also click the Show All button or Hide All button.

Note. You can hide or show air defense areas and SAM threat zones, which are displayed on the map. An air defense area covers the maximum detection range of the Early Warning Radar or SAM radar. Note that the radar itself may be hidden.

If you want to hide a specific ship, aircraft, or other active object, point to the object and click the right button. This will activate the shortcut menu; select Hide.

Previewing objects

If you want to have a look at a 3D model of a particular object and to get a description of its main specifications, select the object in the Encyclopedia from the Main menu.

Undoing changes

If you need to undo the last action such as selecting, moving or deleting a single object or a group of objects as well as changing object properties, click on the Undo button on the Planning Toolbar or select Edit, Undo from the menu (press Ctrl+Z). You can undo as many changes to objects as you need because the Mission Editor stores records about all changes made in the current session.

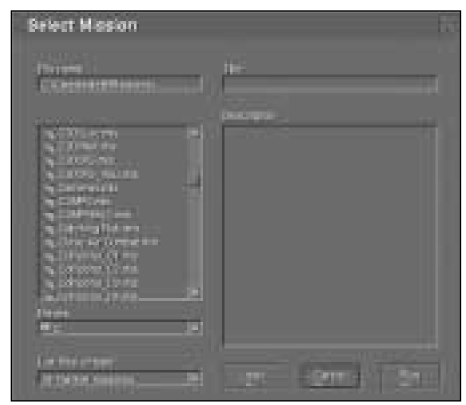
PLANNING YOUR MISSION

Missions

If you want to create a mission from beginning to end fully using the resources of all sides taking part in the hostilities, you will find all necessary information in Chapter 13, “Building new missions”. However, we suggest that you familiarise yourself with the information in the given chapter before tackling such a serious task, as this very chapter describes the main methods of planning.

Normally, the process of mission planning and execution includes the following steps:

1. Loading a mission of a certain class into the Mission Editor.
2. Familiarisation with the mission objectives.
3. Depending on the class of mission and resources available: planning combat tasks for all the objects that should take part in the mission (aircraft, EWR stations, SAM systems, and ships).
4. Flying the mission on your own or performing in automatic mode.
5. Debriefing and mission analysis.



12-1: Select Mission menu

Loading and Saving Missions

To load a combat mission, select File, Open Mission. First, select the All Flanker Missions class in the List files of type field, for example. This will display a list of all missions of that class which reside in the current directory. Select the desired mission from the list. The Title field may change to show the brief message related to the selected mission. In so doing, the text box below shows the mission briefing.

After you have found the desired mission, load it into the Mission Editor by pressing the OK button. If you are already familiar with the mission and don't need to view the map, you can start it immediately by pressing the Run button.

Note that if you try to load a mission while editing another one, the Mission Editor will prompt you to save the active mission.

As soon as you finish planning the mission, you should save it. Otherwise, when you start the mission the simulator will run the old version of the mission. To save the active mission, select File, Save or press the Ctrl+A keys. The mission will be saved under the same name as when it was loaded into the Mission Editor. Sometimes it may be inconvenient because this erases the initial version of the mission to which you might want to return later. To save the mission under another name, select File, Save as. This activates a dialog box where you have to specify a new file name for the active mission. The file extension can be omitted since the Mission Editor automatically adds '.mis' to the file name. To label the mission with a brief message, type the required text in the Title field. To complete the saving, press OK.

Mission Briefings

12-2: Briefing menu

When loading an unfamiliar mission, you first should get the description of the mission objectives and operational intelligence. Additionally, this information includes loadout information, a weather report, and mission start time.

To get a mission briefing, select Flight, Briefing.

The start time for the entire mission is selected by filling in the "Start at" area. If you select a different time in the "till" area, then the mission will start at a random starting time, somewhere in between the 2 times.

You may also change the country that the player will be fighting for in the "My Country" box. You can write a briefing that the player will see when they select the mission in the Description area. You need to select the OK key in order for all of your changes to take effect.

Description

This text box contains the detailed information about the mission objectives, enemy forces, available resources, and weather.

No matter who you are - a novice pilot or a general, you will be given the mission objectives

You should take good account of the meteorological conditions.

Once you have understood the information in the briefing, turn your attention to the map. The map will show you the targets you must attack or defend. By convention, the targets to be attacked (SAM sites, ships, buildings, ground vehicles, and so on) will be marked by red flags and/or numbered triangles.

TRACKS (DEMO MISSIONS)

If you wish to record a mission, then select Flight, Record Track (Ctrl+R) instead of Start Mission. At the end of the mission, you will be prompted to save the track. If you do, then it will be loaded in the editor. You can view the object information within the editor, but you cannot change it (since it is a recording). If you want to add voice to the recording, then, using a microphone, select Video edit from the Flight menu and hold down the 0 (zero) key while speaking into the microphone. You can talk as long as you want and in as many segments as you want.

Play Track

If you have a track file loaded in the editor and want to watch it, then select Flight, Play Track. If you select Start Mission, you will be flying the mission and not watching it. When watching the track you can use any camera view. The camera views that you used in the original recording will also be recorded. At anytime during the playing of a track, you can take over the aircraft yourself (assuming it is an aircraft assigned to "Me") by selecting the Esc key. You will then be flying a mission where you interrupted the track.

Video Edit

If you wish to change the camera views that take place in a track, select Flight, Video Edit (Ctrl+V). This will start the track and record any new camera view selections you make.

UNDERSTANDING COMBAT TASKS

Each active ground, naval, or airborne object taking part in the mission has a specific task that it carries out according to a particular degree of "artificial intelligence". Besides, there are static ground objects (tanks, automobiles, etc.) which in the current version of the sim cannot move and are not provided with their own logic. However, they serve as potential targets for attacking or defending.

The main distinction of an aircraft from other active objects lies in the fact that you can (and must) plan for it a certain combat task according to which the aircraft will act. (You should create the flight plan, choose the weapons and fuel load, allocate the targets). As for ground and naval objects, you can only specify their locations. Nonetheless, our simulator will allow you to specify the skill level for both the pilots or crews of aircraft and the crews of SAM systems, ships or the

personnel of EWR stations. One or another skill level specified for an object will dictate its tactics. Our program allows you to specify for each active object one of the following skill levels: Average, Good, High, Excellent. On the whole, the higher the skill level the less the reaction time of the object, the less the time the object spends on reaching a decision and the better the precision of trajectories and targeting..

Computer-controlled (automatic) aircraft should know how to accomplish their combat tasks because aircraft of the same type can act differently even within the limits of the same mission. For example, the first MiG-29 may effect an intercept, the second - fly a simple CAP mission, whereas the third MiG-29 may seek and destroy enemy radar. Apart from the fact that the type of combat task determines the tactics of the aircraft, it also affects weapons selection. In particular, this means that if the aircraft gets a CAP task you won't be able to load bombs onto it.

To carry out the combat task allocated to your aircraft, you have to do it yourself. By this is meant that if you have chosen (or you have been allocated) a bomb strike, then you have to fly the aircraft to the bomb delivery point and deliver the bombs on your own, though you can get some help from the autopilot. Furthermore, the type of combat task allocated to you and the real results of its execution are taken into account during evaluation of the success of your mission.

Note that the choice of a combat task only decides the general behavior of the aircraft and the available options of weapons. The following are descriptions of combat tasks that can be assigned to aircraft. Naturally, you can allocate only certain combat tasks to a specific type of aircraft. It would be strange if you could assign an intercept task to the Su-25 or a bombing task to AWACS aircraft.

Observation

By default, each new aircraft added to a mission is devoid of any specific task. Correspondingly, it will not have any weapons loaded except perhaps the cannon. Such a plane does not take part in any active actions against enemy aircraft or ground installations and just follows its route. Under the threat of an enemy attack the aircraft will try to evade it.

Intercept

This is a defensive tactic whereby the aircraft must carry out an active search of incoming enemy aircraft and/or receive targeting data from ground based or airborne radar. This type of combat task is reserved for large scale defense and active patrolling and you should not use it while defending a small area or a local installation. The interceptor while chasing the enemy may deviate far from his planned route and the area he is supposed to defend will be left undefended.

This task supposes the use of both long-range and short-range AAMs (R-27 Alamo, R-73 Archer) for intercepting enemy aircraft and cruise missiles and the use of R-77 Adder missiles for intercepting enemy guided missiles. The most suitable aircraft for intercepts are the Su-27 and the MiG-31. Among western fighters this task would be typically carried out by the McDonnel Douglas F-15, which carries four medium-range AIM-120 AMRAAM missiles and four short-range AIM-9P Sidewinder missiles.

Fighter sweep

The fighter sweep mission is a combat task that involves combing air space to attack enemy fighters or other types of aircraft. The main objective of a fighter sweep is winning air superiority and to ensure unimpeded use of the air space by allied aircraft.

In a fighter sweep you can use the Su-27, MiG-29 and MiG-23 fighters. All the aircraft taking part in this task carry long-range and short-range AAMs and the Su-27 in addition to them may carry an external active ECM station Sorbtsiya.

Since the aircraft taking part in a fighter sweep may find themselves at a considerable distance from their airfields and take part in prolonged dogfights, their fuel load will be a crucial factor. Certain aircraft such as the MiG-23 and MiG-27 can carry additional external fuel tanks.

Combat Air Patrol (CAP)

For the purposes of defending a relatively small area you can use the Combat Air Patrol (CAP) or Ground Alert Intercept (GAI). In a specific situation the choice of a CAP or GAI mission depends on many factors. Among them are the nature of a probable enemy attack, reliability of the information about its route, the number of defending fighters and their capabilities.

The CAP mission implies flying a large rectangular pattern round and round following a given route to defend some area from enemy aircraft. This type of task does not involve spotting and destroying enemy ground targets or a significant deviation from the planned route to intercept aircraft. One of the advantages of the CAP is the possibility of intercepting enemy aircraft at long distances from the target being defended. This is especially important if you expect enemy aircraft armed with long-range stand-off weapons (for example, cruise missiles) that can be launched many miles away from their targets. Besides the time factor, the CAP is well suited to situations where the direction of approach or route of enemy aircraft is known with some degree of certainty.

A typical CAP route degenerates into a heavily flattened ellipse, the long axis of which is lined up in the direction of possible threat (see the figure below). You can set up a CAP station for patrolling with the use of both one and several aircraft. (For example, it can involve two aircraft flying toward one another.)

The distance at which you place a CAP station depends on many factors: the number of patrolling aircraft, the size of the area being defended, and the nature of its ground based air defense. Sometimes the use of GAI or only ground based air defense may be more efficient. But beware of standoff weapons!

When planning a CAP mission, the choice of altitude and speed of flight is of no small importance. Plan to patrol at the expected altitude of the incoming enemy aircraft and take your weapons load and weather into account. Be aware that high altitude CAP will make life for low level interdiction real easy and a high/low CAP sandwich might be more suitable.

The crucial factor while patrolling will be the fuel load limiting the distance and duration of CAP. All automatic aircraft in our simulation stop patrolling and return to base in a straight route as soon as their fuel falls to the guaranteed minimum required for the return flight.

On the whole, the use of CAP alone for air defense is difficult and insufficient. However, sometimes CAP may be fairly well suited, especially in the following circumstances: the area being defended is not very large; your fighters have sufficient resources; the sector of possible threat is limited; and if the enemy attacks in small force without large fighter escort.

Ground Alert Intercept

In many circumstances GAI usually proves to be preferable and more flexible for the organization of air defense than CAP. When taking part in a GAI mission, the aircraft is on alert duty on the runway with warmed-up engines. On receiving AWACS targeting data the aircraft takes off and effects an assisted intercept. Since high top speed and climb rate are extremely important for GAI, the most optimal aircraft for this task are the Su-27, MiG-29 and MiG-31. Note, however, that in our program the GAI task can be allocated only to automatic aircraft. We wouldn't want you to stay Earth bound sitting on hot alert in the cockpit for long stretches of time waiting for intercept data. This can prove to be very boring and frustrating. If the enemy attacks with several aircraft, the aircraft on GAI duty will take-off one after another intercepting one enemy aircraft each. (Provided that you have allocated the GAI task to a sufficient number of aircraft.)

When planning this type of mission you don't need to design waypoints and action points. All you have to do is just set the takeoff point, declare it as a GAI station, and let the EWR and AWACS systems vector the aircraft accordingly. Note that intercept aircraft rarely have a complete weapons suite in order to offer maximum rate of climb and manoeuvreability. Note that when planning GAI the aircraft on hot alert don't appear on the runway until the target data becomes available.

The GAI concept is not without drawbacks. First of all, the EWR systems must detect enemy aircraft in good time; otherwise the aircraft on GAI duty on the airfield may become sitting ducks . Furthermore, to repulse attacks from any direction, the airfield with the aircraft on GAI duty must be sufficiently close to the installations being defended.

Escort

This task is allocated to fighters and involves escorting allied aircraft (transport aircraft, bombers, or attack aircraft) and defending them in some air corridor along the route from possible attacks of enemy aircraft. In doing so the escorting fighters should not engage in fights with the enemy aircraft if the latter do not close in on them and do not display aggressiveness.

You should plan the number of escorting fighters depending on the importance of the combat task allocated to the escort and the probability of an encounter with enemy interceptors on route.

Antiradar

This task involves searching for enemy EWR stations and SAM sites in a given area, and attacking and destroying them using antiradar missiles of the Kh-25MP Karen or Kh31P Kegler types. Note that you cannot use antiradar ASMs against airborne targets (for example, AWACS aircraft), as antiradar missiles are not designed to track fast moving manoeuvreing targets.

Antiship strike

This task consists in actively searching for enemy surface ships in a given area then attacking and destroying them. In so doing you can use antiship missiles of the Kh-15 Kickback, Kh-31A Kegler, Kh-35 Krypton types or cruise missiles of the Kh-55 Kent and Kh-65 types.

Pinpoint strike

The Pinpoint strike mission involves active search for ground and surface targets in a given area and attacking and destroying them using precision missiles of the Kh-25 Karen, Kh-29 Kedge types, or cruise missiles of the Kh-55 Kent and Kh-59 Kingbolt types. Besides the above weapons, to deliver a pinpoint strike, the aircraft can carry guided bombs of the KAB-500 or KAB-1500 types.

Ground attack

This task consists in purposely searching for enemy ground targets (plants, railroad stations, airfields) in a given area then attacking and destroying them in general using bombs. This type of mission usually involves using unguided bombs weighing from 250 to 1500 kg or the KMGU unified containers. In addition, the aircraft can destroy targets with the aid of unguided rockets.

Close Air Support (CAS)

CAS involves actively searching for enemy ground targets on the battlefield and destroying them. Here absolute precision in delivering strikes is not of crucial importance. This type of mission usually involves using the S-8, S-13, S-24, and S-25 unguided rockets and unguided bombs. The Su-25 ground attack aircraft is best suited to CAS, though such planes as the Su-27, MiG-29 or and MiG-27 can successfully handle this task.

AWACS (Airborne Warning And Control System)

This task can only be allocated to the A-50 AWACS aircraft, which is a highly modified version of the IL-76 transport aircraft or to the American E-3A. The AWACS aircraft flies according to a planned straight or circular route and alerts allied aircraft, SAM sites, and ships when it detects enemy aircraft.

The advantages provided by the AWACS aircraft are evident. Furthermore, the S-300PMU and Buk SAM systems can receive targeting data directly from the AWACS even when their own acquisition radar have been destroyed. The sole drawback of the AWACS aircraft is its high vulnerability, especially as it is a much prized target for enemy fighters. Often you can use ground EWR stations instead of the AWACS aircraft to assist you.

Mission Classes

All mission classes differ from one another by the number and type of resources you will have at your disposal and, hence, by the amount of work involved. The Flanker offers you three combat mission classes:

- Pilot mission
- Squadron leader mission
- General mission

In our simulation you can plan and perform several versions of the same mission to compare the results and find the optimal solution.

Potential detection zones and threat zones related to enemy AAA, SAM systems and ships are shown on the map as as circles, however, the objects themselves may be concealed. Naturally, you should plan missions allowing for these threat zones. However, note that such a zone represents the maximum engagement envelope of the corresponding enemy weapon and does not consider terrain masking or aircraft's altitude and speed. This means that carefully planned routes allow aircraft to successfully fly even in threat zones.

Pilot mission

Here the combat task is usually formulated very particularly, for example, strike a particular ground target or intercept an enemy fighter. We recommend that you begin mastering the Mission Editor from the Pilot mission class as it is the simplest.

The pre-set flightplan, weapons and fuel load of your aircraft are typical for a Pilot mission. As a pilot, all you can do in the Mission Editor is familiarise yourself with the flightplan on the map. You neither can change your flightplan, weapons load and fuel load, nor add new objects to the battlefield. All you should do is fly your mission strictly following the pre-set flightplan. The main criteria that the program will use for evaluating the success of your sortie are the achievement of the mission objectives, total flying time, the number of destroyed enemy aircraft, and the type and quantity of the weapons employed.

Note, that while being just a pilot you generally cannot influence the outcome of the entire mission where other allied aircraft, ships, and SAM systems can also take part. However, in our sim the success of any pilot mission is evaluated only by your own combat actions. The detailed debriefing of your sortie showing all the events that occurred during the mission will be made in the Debriefing dialog box.

Squadron leader mission

The Squadron leader mission class gives you more leeway in deciding how to achieve the mission objectives than a junior pilot. A squadron leader can select the number of aircraft he will need (up to four), the skill of his wingmen, and the aircraft ordnance. He can modify or design the flightplan for his wing and designates action points.

A squadron leader cannot add new objects to the mission or change properties of the existing ones. His goal is to achieve the mission objectives with the least losses. The success of a squadron leader mission is determined only by the actions of the squadron irrespective of how lucky the other allied forces were.

General mission

Combat missions of the General mission class are the most difficult for planning. They require fine tactical thinking. For example, he can be ordered to defend a city from enemy aircraft raids, or to deliver a mass airstrike on enemy installations.

To achieve the mission objectives as a general, you have at your disposal considerable resources including a range of aircraft, SAM systems, radar, all types of aircraft ordnance, and unlimited fuel supplies. Note that in any general mission you can remain as an observer or take part in the mission as a pilot or squadron leader. In distinction to pilot and squadron leader missions, the program evaluates the success of a general mission primarily by the actions of all the allied air, naval, and ground forces. To a lesser extent the mission result will depend on your actions as a pilot, though it may happen that you will be the very person who will predetermine the outcome of the entire mission.

Nation Briefing

Russia

Despite its economic woes, Russia still fields the largest military force in the area included in Flanker. Soviet military doctrine, which undoubtedly forms the backbone of current Russian military philosophy, is based on the divisional concept. Tank, Motorized Rifle, and Airborne divisions are combined into armies. Typical armies consist of:

	COMBINED ARMS ARMY	TANK ARMY
Tank Divisions	1 to 2	2 to 4
Motorized Rifle Divisions	2 to 4	1 to 2
Artillery	yes	yes
Missile Support	yes	yes
Air Defense	yes	yes
Intelligence	yes	yes
Logistics Assets	yes	yes

Three to five armies comprise a front, the largest wartime field formation. Fronts are deployed throughout the theater of action along strategic axes leading to key enemy positions.

Russian offensive operations utilize an echelon, or wave concept. The first echelon, consisting of roughly 1/3 to 1/2 of the entire formation, attacks first, penetrating as deep as possible through the enemy lines. The second echelon held in reserve, launching a second wave through ground gained by the first attack. The two echelon's continue to "leap frog" toward the enemy's rear.

Russian ground forces would consist mainly of T-80 and T-72 Main Battle Tanks along with BMP-1, BMP-2, and BMD infantry fighting vehicles. BTR-50, BTR-60, BTR-70, and BTR-80 Armored Personnel Vehicles would be quite prevalent. SA-4 and SA-11 SAM systems will deploy at the Army/Front level. SA-6, SA-8, and SA-15 will deploy at the Division level. SA-9 and SA-13 will deploy at the Regiment level. Man-portable SAMs (SA-7, SA-14, SA-16, SA-18) will accompany all ground forces. Su-27, Su-33, MiG-29, and MiG-31 aircraft will provide the backbone of Russian aviation, with MiG-23, MiG-27, and Su-25 aircraft performing a wide variety of tasks. The Black Sea Fleet, including 4 cruisers, 5 destroyers, and 21 frigates, has largely been under Russian control, despite various "joint control" agreements between Russia and Ukraine.

Ukraine

Once part of the Soviet Union, Ukranian military forces are dominated by Soviet-built equipment and tactics. Ukranian army, numbering some 212,000 troops, is divided into five major commands.

Main Battle Tanks: 345 T-80; 1,320 T-72; 2,345 T-64; 85 T-62; and 680 T-54/55

AIFV: 1,325 BMP-1; 1,460 BMP-2; 6 BMP-3; 124 BMD; 490 BRM

APC: 220 BTR-60; 2,000 BTR-70; 450 BTR-80; 40 BTR-D

Artillery: 3,685

SSM: 132 Scud; 140 FROG/SS-21

SAMs: SA-2; SA-3; SA-4; SA-5; SA-6; SA-8; SA-10; SA-11; SA-12A; SA-1

Naval Bases: Sevastopol, Odessa

Navy: 2 Krivak-III; 1 Petya-II,1 Grisha V

Naval Aviation: 63 MiG-29; 45 Su-17; 44 Su-25; 18 Tu-16; 39 Tu-22M.

Air Force: 140 MiG-23; 73 MiG-25; 146 MiG-29; 57 Su-15; 66 Su-27; 34 Su-25; 166 Su-24

Turkey

A NATO member, Turkey has not always agreed with the U.S. on military policy, often restricting the usage of U.S. planes stationed there. Perhaps as a result of constant friction with Greece, Turkey has continued to modernize its military, acquiring F-16s along side F-4 Phantoms.

Main Battle Tanks: None

AIFV: 286 IAPC; 2,815 M-113; 475 AWC

Towed Artillery: 1,618

SP Artillery: 820

MRLS: 12

SAMs: 108 Stinger, 789 Redeye, 92 Nike Hercules; 24 Rapier

Naval Bases: Ankara, Istsanbul, Izmar, Eregli, Iskenderun, Aksaz Bay, Mersin

Navy: 3 Gearing-class FF; 2 Carpenter-class FF; 8 Knox-class FF; 8 other FF; 44 Coastal Patrol Vessels

Naval Aviation: 9 S-2

Air Force: 146 F-16C; 108 F-5; 184 F-4E; 40 RF-4E; 2 KC-135R

United States

Although it has a fair number of assets stationed in Europe and Turkey, both regions have become increasingly less friendly to hosting U.S. forces over the years. Land-based jets operating out of Europe would need to gain appropriate authority to cross various nations' airspace. Long flights necessitating numerous in-flight refuelings while navigating around non-cooperative nations could severely limit U.S. participation in the war. Depending on the political circumstances, U.S. forces would undoubtedly seek staging areas closer to the combat, particularly in Turkey. Turkey often places restrictions on the usage of U.S. aircraft based there, though. Consequently, naval air power would very likely dominate the show, at least until the political hurdles restricting land-based aircraft operations could be ironed out.

Given the size of the U.S. military, it would be difficult (and pointless) to list the quantity of each platform in its arsenal. Suffice to say, the U.S. has substantially more equipment than Turkey and Ukraine combined. The quantity of platforms available would vary greatly depending upon the political situation in Washington. Most likely, the U.S. would attempt to limit its involvement to airstrikes. As seen over Kosovo, U.S. would likely use airpower and avoid committing ground forces unless absolutely necessary. A typical U.S. air campaign should initially focus on eliminating enemy air defenses and early warning radar, followed by establishing air superiority. With carrier based operations, E-2 Hawkeyes would maintain constant patrols with F-14s providing combat air patrols. F/A-18s would conduct the bulk of the strikes, accompanied by EA-6B electronic warfare aircraft. If land-based aircraft are involved, the E-3A Sentry would be the preferred over the E-2 for AWACS duties and the F-15C would likely handle most combat air patrols. F-16s, A-10s, and F-117s would all probably be utilized in ground attacks.

On the ground, U.S. forces would consist primarily of M-1 Abrams and M-60 Main Battle Tanks, accompanied by Bradley IFVs along with HAWK and Patriot SAM systems. The Navy 6th Fleet could be expected to deploy at least two aircraft carrier battle groups to either the eastern Mediterranean and/or the Black Sea.

Defense Visual Information Center - Department of Defense

BUILDING NEW MISSIONS

Creating missions is a fairly easy task thanks to the mission editing system; however, creating entertaining, well-balanced and realistic missions takes some forethought and work. In this section we examine mission design philosophy as well as examine how various nations employ specific weapon platforms.

Notes on Good Mission Design

Before we can discuss how to create a "good" mission we have to first identify what "good" means. "Good" in this context generally means the mission meets the designer's objectives. For example, if the objective is to create a realistic representation of the modern battlefield you wouldn't want to place the player alone against a few dozen enemy aircraft. If, on the other hand, the intent is to create an action-packed, exciting "shoot 'em up" scenario, then you wouldn't want the player to fly 30 or 45 minute stretches without encountering any enemy activity.

The first key, therefore, to creating a "good" mission is to identify what type of mission you want to create and applying resources inside the mission accordingly. An action-oriented mission, naturally, should include lots of enemies positioned close to the player. Such missions don't require a lot of forethought. If the pace is fast and furious, you've probably got it right.

Missions designed for competitions and tournaments should conform to different criteria. Missions used in competitions generally needs to be repeatable. That is, it should perform basically the same each time to be fair to all players. Although dealing with random event and surprises may well be part of the competition, such events should be reasonably controlled and present equivalent (if not exactly equal) challenges to each contestant. It's hardly fair or reasonable for one contestant to battle a dozen F-15s armed with AMRAAMs while another contestant meets only an unarmed C-130. Use random events sparingly and in well-controlled circumstances to present specific challenges.

A realistic battlefield recreation, whether a stand-alone mission or part of a user-built campaign, requires the most thought. Keep the following few hints in mind:

- Ensure that each side uses the appropriate hardware and units in the appropriate rules. See the Nation Briefing later in this chapter for information on individual nations' inventories and tactics.
- Properly position individual units. This item may require the most planning and attention to detail. Some SAM types are generally positioned at divisional or battalion headquarters; other types accompany troops near the fighting. See the Platform Briefing later in this chapter for details on common roles and placements for different unit types.
- Use reasonable quantities. Placing two dozen SA-10s around an airfield may provide adequate protection from capitalist aggressors, but is hardly realistic. Budget constraints on both sides of the iron curtain prevented either site from acquiring such quantities of equipment during the Cold War.
- Apply proper force balancing. Obviously, Russia could field a significantly larger force than Turkey. Depending on the type of conflict you're simulating you'll want to alter the force balance. To simulate an all-out war, Russia would have an overwhelming majority. To simulate a longer duration, limited-scale conflict, Russian forces should be pared down.

MISSION BUILDING STEPS

The option of creating new missions is among the more important features of the Mission Editor. With its help you can simulate practically any combat situation and perform the mission yourself or distribute it to your friends or the world at large via the Internet. If you intend to give your mission to other players, you can limit their available resources and hide information on enemy objects

While designing new missions we recommend that you follow the sequence of steps presented below:

Add Aircraft

Let's begin by adding a group of two Su-27s. Select File, New from the menu (Ctrl+N). Then click the "New Aircraft" button on the toolbar. Since there is no sides chosen yet, the "Form Coalition" window will appear. Use the arrow keys to assign Russia, Ukraine, Turkey and U.S.A into two teams. It is not necessary to assign all four nations; you only need one nation assigned to each team. For this example, assign Russia and Turkey to the first group and Ukraine and U.S.A. to the second group. When finished, click "OK."

Next, select the start time for the mission by opening the Flight, Briefing (Ctrl+B) menu. Write in the starting time in the "Start at" area. Time is expressed in military terms (ie., 3pm is 15:00). The first box is the day, the second the hour and the last is the minute. If you select a different time in the "till" area, then the mission will start at a random starting time, somewhere in between the 2 times.

You may also change the country that the player will be fighting for in the "My Country" box. You can write a briefing that the player will see when they select the mission in the Description area. You need to select the OK key in order for all of your changes to take effect.

13-1: The Airgroup Planning Window

Now select the "New Aircraft" button again. The Airgroup Planning menu will appear.

The "Airgroup Planning" window now appears. Click in the "Group" box, and change the name of this flight to "CAP 1" by writing in the box. Select "Ukraine" for the country. Select CAP (Combat Air Patrol) from the "Sortie" pull-down menu.

Aircraft Menu

13-2: Selecting Aircraft

Next, click the "+" on the Aircraft bar, expanding the "Airgroup Planning" window. Select Su-27 as the type and select CAP as the task. The Pilot box now displays "Pilot 1." Designate this aircraft as the one you intend to fly by clicking the "Me" checkbox, just below the Skill box. Add a second aircraft by increasing the number to 2 in the box next to Skill. Then set the skill to High from Average. Finally, select the desired colour scheme for each aircraft. Remember, to move from one aircraft to another, use the Pilot box. If you change the number in the "of " box, this will add or delete aircraft. When you're finished, condense the Aircraft menu by pressing the "-" button. You've now created a group with two Su-27s.

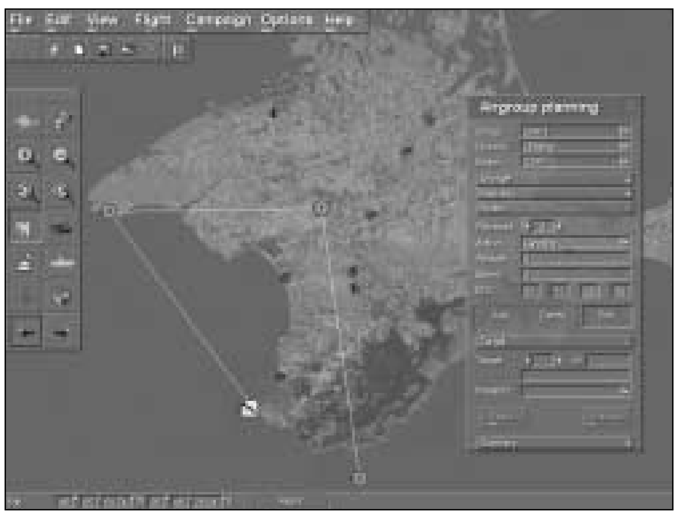
If you wanted to add more wings to an airgroup, you would use the last of the Wing # of # boxes to add/delete wings. The first # box allows you to look at the various wings. Wings may have different tasks, as long as they are allowable under the airgroup's sortie type.

Assigning a Payload

Expand the "Payload" bar and customize the payload for this flight group. Select a weapons package from the "Weapons" pull-down menu and select fuel quantity from the "Fuel" pulldown menu. The full weapons loadout will be shown in the loadout window. The weight of the fuel and weapons will be calculated and displayed next to the maximum take-off weight. If you exceed the maximum TO weight, you must reduce the fuel or weapons quantity. Compress the payload menu by pressing the "-" button.

13-3: Configuring Aircraft and Payload Within a Group

Creating a Route



13-4: Creating a Route

Expand the Route menu. Create a flight path by click on the map; each point you click becomes a waypoint for the selected flight. If you wish to move a waypoint, select the "Edit" button and click on that waypoint and drag it to the new location. You may delete the selected waypoint by pressing the Delete button in the "Airgroup Planning" window.

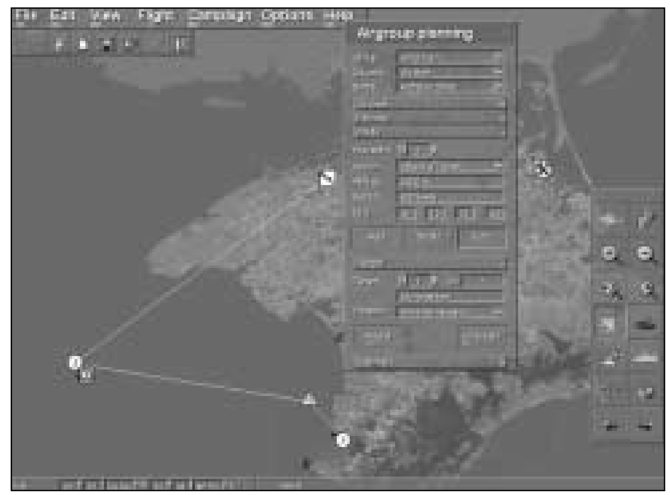
Let's create a combat air patrol (CAP) mission. Create the 0 waypoint at the very bottom of the map. Create the #1 waypoint in the very center of map. Create a #2 waypoint due west, along the right edge of the map. Place the last waypoint over any airfield. In the "Route" menu, select the 0 waypoint, using the arrows next to the Waypoint box. Set the action to "Turning Point." Set the altitude to 5,000m and the airspeed to 700 km/hr.

Next, select the #1 waypoint. Set the action to "Begin Loop." Set the airspeed and altitude as desired. Move to the next waypoint, setting the action to "End Loop." Finally, move to the last waypoint and set the action to "Landing."

Now, using the step above, create an enemy Fighter Sweep sortie of MiG-23s. To make finding them easy, ensure that your waypoints intersect each other around the same time. Check the ETO in the Airgroup Planning, Route sub-menu for waypoint timing. Don't forget to give them a weapon loadout (unless you want flying targets).

Select Flight, Start Mission (Ctrl+F). When the mission begins, the airgroup will start at waypoint 0. After flying to waypoint 1, the group will cruise at the specified speed and altitude between waypoints 1 and 2, until running low on fuel. The group will then turn to waypoint 3 and land

Assigning A Target



13-5: Assigning Targets

For Ground-Attack, Runway Attack, Anti-radar, Anti-ship, CAS (Close Air Support) and Pinpoint Strike missions, you can assign the group to attack a specific surface target. A surface target can be anything on the surface, including ships, static objects, buildings, bridges, etc. You can use either the Object or Coordinates option in the Select Target menu to designate a target. The steps are very similar to the ones described above, with the addition of target designation. Let's run through the steps needed to create Anti-Ship strike.

- Select a New (Ctrl+N) mission.
- Select New Ship (the target) from the Toolbar.
- Chose sides in the "Form Coalitions" menu. Side 1=Russia. Side 2=Ukrane
- Select New Ship (the target) from the Toolbar.
- Using the Type box, select the Elnya Tanker. Select Ukraine as the Country.
- Set the ship on the map by left-clicking the mouse somewhere on the water.
- Select New Aircraft from the Toolbar.
- Select the Country (Russia) and Mission (Anti-Ship Strike) in the Airgroup planning menu.
- Expand the Aircraft sub-menu , select your aircraft (Su-33), check the "Me" box, and choose a colour scheme. Add other AI pilots if you wish. Close the Aircraft sub-menu.
- Open the Payload sub-menu and select your weapons and fuel payload. Close the Payload sub-menu.
- Open the Route menu and then place 4 waypoints on the map, with the #2 (3rd) waypoint being near the Elnya Tanker. Set the last waypoint near an airfield. Set the altitude for all of them at 2000m and a speed of 800km/hr.
- Select the #1(2nd) waypoint in the route menu and set the action to Attack.
- Open the Target sub-menu (ensuring that the route menu is still set to the #1 waypoint) and select the Assign button. With the Select Target menu set to Object, use your mouse to select the Elnya Tanker. Press OK on the Select Target menu.
- In the Target sub-menu, select the type of weapon you want to use or select "Any Weapon".
- Close the Airgroup Planning menu.
- Select Start Mission (Ctrl+F)

When the mission begins, your aircraft will start at waypoint zero. When it reaches waypoint 1 (where Attack was set as the action), you will commence your attack on the target. After the attack, you will continue on to the remaining waypoints.

Note: had you selected the attack to be performed by an AI aircraft and you forget to select Waypoint 1 as "attack" then the aircraft would have just merrily flown its flight path and not engaged. Furthermore, regardless of where you place the "attack" waypoint the AI aircraft will attack the asigned target. This is extremely important when planning to attack with standoff weapons such as cruise missiles. The AI aircraft must know when he can start "thinking" about launching the attack. Furthermore, after release of the weapons he must either go home or chooe the next waypoint making sure that the flight path doesn't take him right over the target zone.

Add SAM Site

Anti-aircraft systems come in two basic types: independent and complexes.

Independent Anti-Aircraft Systems

Independent systems include AAA and man-portable SAM systems, and are basically self contained and fully functional. Units may be placed anywhere, providing the terrain is suitable (you can't place them in the water or on a mountain side, for example).

	TYPE
1	2_6_ "Tunguska"
2	ZSU-23-4 "Shilka"
3	Roland
4	Avenger
5	Gepard
6	"Igla"
7	"Dzhigit"
8	Stinger

Air Defense Complexes

Larger, more capable SAM systems are comprised of a series of sub-components. Each site will need at least a search radar (usually considered the "basic" element) along with launchers and other support vehicles. The secondary objects may be "obligatory" (required), or not. The following table shows the composition of common SAM complexes.

	COMPLEX	ELEMENT	BASIC	OBLIGATORY
1	S300 PS	5_63_ search radar		+
		40_6__ search radar	+	+
		40_6_ track radar		
		64_6_ low altitude search radar		
		5_85_ launcher		+
		5_85_ launcher		
2	S300V	9_15__ search radar	+	+
		9_32 track radar		+
		9_19_2 sector track radar		
		9_82		+/-
		9_83		+/-
		9_84		
		9_85		
3	Buk	9_18_1 search radar	+	+
		9_310_1 launcher with track radar		+
		9_39_1 loader - launcher		

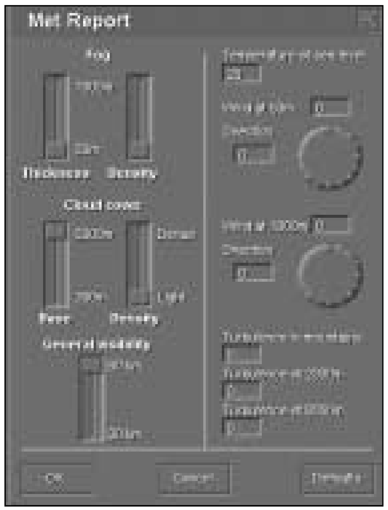
continues…

7. Repeat steps 2-4 until you set up all the objects of the given class.

All units comprising a SAM system are placed individually. Note that you cannot place launchers farther than 1000 meters from their radar. If the units are not placed properly, the SAM system will fail to work.

After you have placed all the objects, you can exit from the set up mode by clicking the corresponding sunken button on the Planning Toolbar . Now you can select and move placed objects and change their properties using usual methods. Note that if you wish to move the complete SAM complex use the Ctrl click standard windows function and simply drag the complex to its new location on the map.

Changing meteorological conditions



You specify meteorological conditions in the Met Report dialog box, which can be opened from the Option menu. You fly combat missions at pre-set meteorological conditions unless the mission is unclassified, leaving the flexibility of changing what you wish.

Temperature

Ambient temperature affects engine thrust. The lower the temperature the higher the thrust and therefore the aircraft's speed. Furthermore, fuel consumption is lower in cold weather.

The temperature you specify will correspond to the ambient temperature at sea level. Ambient temperature decreases with altitude. You should specify temperature in degrees Celsius. Allowable temperatures in our simulation range from -20°C (-4°F) to +35°C (95°F). Standard day temperature is +20°C.

Cloud cover

Cloud cover mainly affects optical visibilityYou can specify the intensity of cloudiness (light or heavy) and its lower and upper boundaries. In our sim, clouds cannot lie lower than 300 metres and higher than 5000 metres.

Fog

Fog is a ground level effect with visibity (density) and thickness variation. These paramters can be tuned and combined with general visibility and cloud cover to create convincing weather effects within the sim. Try different combinations and get a hang of what each slider does when combined with each other.

	COMPLEX	ELEMENT	BASIC	OBLIGATORY
4	Kub	1_91 search and track radar	+	+
		2_25 launcher		+
5	Osa	9_33 launcher with search and track radar	+	+
		9_217__2 loader		
		_901 launcher		+
7	HAWK	AN/MPQ-50 search radar	+	+
		HEOS track radar		+
		_192 launcher		+
8	Strela-1	MT-Lbu search radar	+	+
		9_31 launcher		+
9	Patriot	Patriot launcher	+	+
		Patriot Search and track radar		+
10	Strela-10	MT-Lbu search radar	+	+
		9_35 se		+

NOTES:

* +/- means that at least one element marked with this sign is obligatory.

* The S300V 9A84 launcher will work only if 9A82 launcher is included in the complex and 9A85 launcher will work only if 9A83 launcher is included in the complex.

The complex basic element can be located at any place on the map. One or more tracking radar should be located not father than 10 km from the search radar. One or more launcher should be located not father than 1.5 km from the tracking radar.

Placing Radars, SAMs and Ships

To set up a new SAM system, EWR station or ship, do the following:

1. Click the required icon on the Planning Toolbar. This activates the corresponding dialog box, for example: SAMs

2. Select the type that you wish to place. Say BUK

3. Choose a country (allowed only for new missions), the type of system, and a skill level for its crew.

4. To set an orientation of the object you can enter the exact angle in the Heading field or use the special circular scale in the form of a clock. 12 o'clock corresponds to due North, 3 o'clock - due East, and so on. To set the orientation, just click in the required place on the clock-face or rotate the arrow by dragging it with the mouse.

5. Click on the map where you want to place the object.

6. Look at the SAMs Detection and Threat zones by selecting them in the View,Hide Objects menu **Ctrl+H**.

Wind

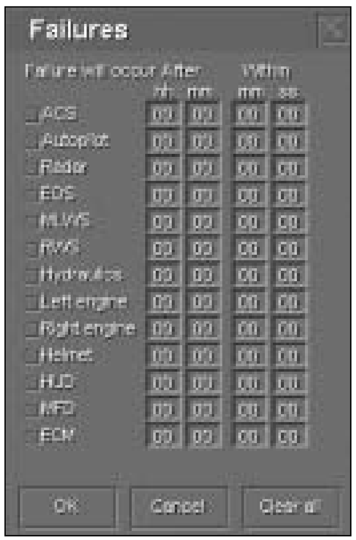
Wind seems to have the most effect on landings (see Chapter 3, “Piloting the Flanker” on how to land the Flanker in crosswind). You can specify the wind speed (km/h) and its direction at two characteristic altitudes: 50 metres and 1000 metres. The maximum permissible values are 54 km/h and 100 km/h, respectively

Turbulence

Atmospheric turbulence is the movement of downgoing and upgoing airstreams causing bumps. The main reasons for turbulence have to do with the friction of airstreams on the ground surface, non-uniform heating of ground, the collision of atmospheric fronts having different temperatures, speeds and directions of movement, and of course rising terrain. Turbulence may lead to reducing flight speed, inaccurate readings of flight instruments, low-amplitude jolting and shaking of the aircraft at high airspeeds. As this takes place, the G-load may change chaotically with dispersion of values that may sometimes be as much as ±2 Gs during strong bumps.

You can specify turbulence by entering the wind speed (m/s) for three characteristic areas - in the mountains and at altitudes of 2000 metres and 8000 metres. The strongest turbulence in mountains occurs on the lee slopes.

Imitating system failures



13-9: Failures menu>

Your aircraft might be damaged in combat as the result of a missile or shell hit. To be ready for such a situation and to be able to fly the aircraft when onboard systems have failed, the program allows you to imitate emergencies.

Select Options, Failures and specify in the dialog box the failures which the program should imitate. Specify the exact failure time for the particular failure you wish to practice or a time between failure (TBF) if you wish to simulate failures without exact failure times but which will occur for sure within that specified time. For example, if you specify 00:30 in the Within field for the radar this means that your Zhuk-27 will fail for sure within the next 30 minutes. If you were to specify 11:30 in the After field you can be sure that exactly 11 mins 30 sec after takeoff the failure will occur. If you specify an After failure time it will have priority over the Within setting.

ACS

A failure of the Automatic Control System (ACS) will cause the Flanker’s flight control system to switch to “proportional control mode” in which a control signal from the stick delivers proportional movement of elevator. The AOA and G limiters are disabled. However, in this situation the aircraft still benefits from a particular degree of stability augmentation unlike in direct link mode when doing a Cobra manoeuvre. If the ACS fails use very smooth stick movement to avoid large angles of attack and G-loads and don’t rely on the Autopilot as it will also be inoperative Note the SDU light on the right hand side of the cockpit illuminates.

Autopilot

A failure of the autopilot leads to the aircraft’s inability to automatically follow the pre-set route or keep a given altitude in the Altitude Stabilisation mode.

Radar

If the radar fails, this denies your aircraft the ability to actively search using the Zhuk-27/Miech-33 radar though you still have the EOS at your disposal.

EOS

A failure of the Electro-Optical System denies your aircraft the ability to passively search for enemies.

MLWS

If the Missile Launch Warning System fails, you will not be able to receive warnings about missiles launched in your direction.

Hydraulics

A failure of the hydraulic system degrades control of your aircraft and can make it uncontrollable. Don’t fly above 30 degrees bank angle and +/- 20 pitch

Engines

If one engine fails, you can still continue flight (see Chapter 3, “Piloting the Flanker” on how to fly your jet with one engine out). If both engines fail at a stone’s throw away from an allied airfield, you might try to land your aircraft, otherwise, eject!

Helmet

When the Helmet Mounted Target Designator (HMTD) fails you cannot use Helmet mode.

HUD

If the Head Up Display fails, the screen goes blank. You still have the option of flying on instruments.

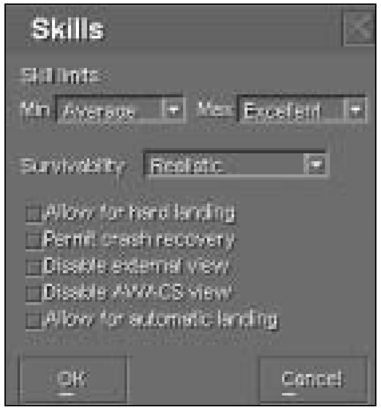
MFD

When the Multi Function Display fails, the screen goes blank.

ECM

If the ECM system is damaged, you cannot employ active jamming using the onboard ECM system equipment and/or the Sorbtsiya external ECM system.

Specifying skills



13-6: Skills menu

This is where you can set skill levels for both the player-controlled aircraft and AI aircraft. The Skill limits area sets the range of skills possible for AI aircraft, when the player selects the "Random" as the AI aircraft's skill. Survivability is where the damage that an AI aircraft can take is set. This is for all AI aircraft in the game.

The check boxes are:

Allow for hard landing: The player-controlled aircraft can take more damage on landing and still survive.

Permit crash recovery: The player can select "Recover" after he ends a mission **Ctrl+Q** in which he crashed. His aircraft will recover to an altitude of 1000m above his last location. This is very handy for continuing multi-player games.

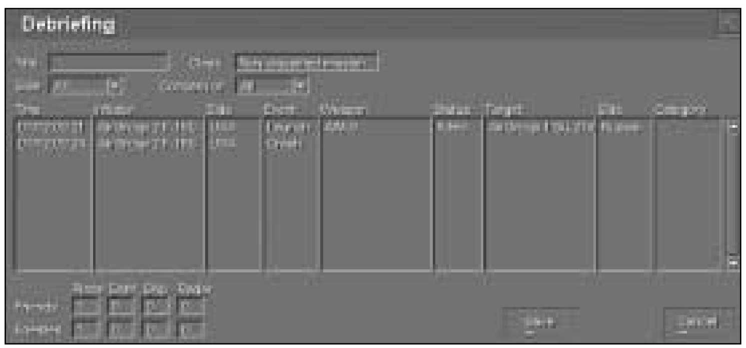
Disable external view: Locks out all external views in the game. Player is in the cockpit only.

Disable AWACS view: Locks out the AWACS (F10) view. Player can use all other camera views.

Allow for automatic landing: Allows the autopilot to take you all the way to the runway when landing. When not enabled, the autopilot will disengage according to Cat I regulations 60m above the runway.

You need to select OK to save any changes you make.

Debriefing



13-7: Debriefing

After you have placed all the objects, save the mission and start it. Now the success of the mission is in your hands, or at least a part of it is.

A mission is ended in the following events:

1. You have quit by pressing **Ctrl+Q**
2. Your aircraft has crashed and you have refused to continue the mission without your participation
3. Your aircraft has successfully flown the mission and has landed. You refused to continue the mission without your participation

You will obviously be interested in the results of the mission. You will automatically get the statistics on the sequence of events when you quit the mission **Ctrl+Q**.

Mission Building Tips

- If the last waypoint for an AI aircraft is in mid-air, then that aircraft will "disappear" from the game when it reaches that point. Set a landing location if you do not want this to occur.
- If an AI aircraft finds itself crossing an enemy SAM threat zone and it has no target to attack in that threat zone, it will delete it's current waypoint and try and go around the threat zone to it's next current waypoint. If there is no other waypoint, then the aircraft will "disappear" as above.
- You cannot set the action in last waypoint as Attack, since the aircraft is supposed to "disappear." It cannot disappear and attack at the same time.
- Do not set an "attack" waypoint for AI aircraft close to the target. The aircraft needs to get itself into an "attack profile." If you set the attack waypoint too close to target, then the aircraft will fly to a point at which it can get into an "attack profile." At this point, the aircraft is wasting time and fuel and maybe risks entering a heavily defended area.
- If you select attack, but do not assign a target to an aircraft, then it will try and find any enemy target to engage, based on the combat task it has been given.
- If you select a specific target for the AI aircraft to attack and you choose the "any weapons" option, then the aircraft will continue to attack the target will all weapons (including cannon) until that target is destroyed. This may not be a wise choice against certain targets (like the Moscow).
- Ensure that you are not selecting the same side/country for 2 objects that you wish to fight against each other. We have found this to be a common mistake.
- If an AI aircraft runs low on fuel, it will divert to the nearest friendly airbase.
- Remember to look at the different pilots in a Wing by using the Pilot box and not the Of # box on the Airgroup Planning menu. Using the Of # box will add or delete aircraft.
- If you delete all of the wings in an airgroup menu, then you will need to add a wing (the right hand arrow of the 2nd box). If you try and close this menu with no wings, you will get the message "No Wings in the Group."
- An AI aircraft will use only enough ordnance to destroy the assigned target. If, for example, the aircraft is assigned to hit a specific location (coordinates) at an airbase, then it will drop 1 bomb salvo (2 bombs). Which is all that is necessary to destroy the target. If you assign it to take attack 5 points on the runway, it will drop 5 bomb salvos.
- If you have a saved or track (recorded) mission loaded in the editor, you will not be able to edit it. Check the status bar at the bottom of the editor to see what file is loaded.

CHAPTER 14
Campaigns

Defense Visual Information Center - Department of Defense

CAMPAIGNS

Flanker 2.0 comes with a multi-phased campaign and can be found by selecting the Campaign button on the main menu.

Campaigns initially play just like missions. At the end of the first phase in a campaign (select the Ctrl+Q key to end the phase), you will get an option to go onto the next phase. When you select that button, you will be taken to the following phase of the campaign, if there is one and if you met the conditions to do so.

Building Campaigns

The Flanker 2.0 Editor allows you to build multi-phased campaigns, with mission conditions for each phase. This gives you the ability to make campaigns that last for weeks and, where every action, results in a change in the location and strength of forces later. You should master building missions before you attempt to build a campaign. It is also important to plan out what your campaign will look like before you start building it.

Let's go through the steps that are necessary to build a very simple campaign:

1. Build a simple mission. For the purposes of this example we will build the following mission:

   Sides: Russia vs. Ukraine.

   Start Time: 01/12:00

   Russia

   2 x Su-33 (you and your wingman) Fighter Sweep mission

Ukraine

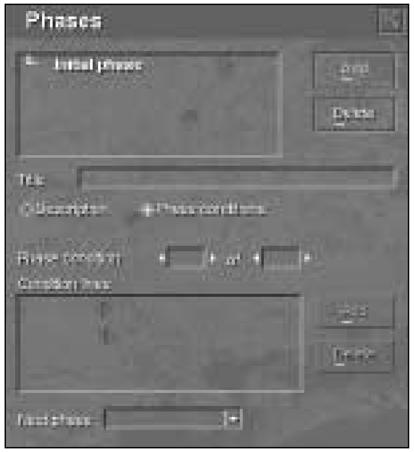
1 x MiG-29s Escort task

1 x A-50 AWACS task

All aircraft start in the air. Your mission is to destroy the A-50 and the MiG-29.

After you build the mission, save it.

2. Then select Campaign, Phases.



10-4: Phases menu

Let's say that if you destroy only the A-50 you want to go to Phase 2 and if you destroy both the A-50 and the MiG-29, you want to go to phase 3.

RESULT FROM INITIAL PHASE	GO TO
Destroy A-50	Phase 2: Fighter Sweep against the surviving MiG-29.
Destroy A-50 and Mig-29	Phase 3: Anti-ship strike against an Orel (Krivak-3).

3. Select Campaign, Phases in the Editor. The Initial Phase is highlighted.

4. Select the Add button. You will see Phase 2 appear.

5. Select the Description button and write in: "Fighter Sweep against the surviving MiG-29" in the Description window.

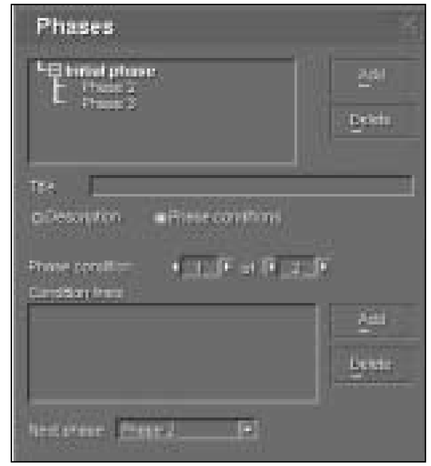
6. Select the Initial Phase using the mouse cursor.

7. Select Add again. Phase 3 should now appear, branching off of the Initial Phase. When you select the Add button, it will add a phase to the currently selected phase. So if you did not select the Initial Phase, then Phase 3 would follow (branch from) Phase 2 (the selected phase). You would not be able to get to Phase 3 from the initial phase in the campaign.

8. Select the Description button and write in "Anti-ship strike against an Orel (Krivak-3)" in the Description window.

9. Select the initial phase again.

10. Select the Phase Conditions radio button. Your menu should look like this:



14-2: Phases menu

Notice that it is Phase Condition 1 of 2 and that the Next phase is Phase 2

11. Select the Add button in the Phase condition area (near the bottom of the menu). You should see the Edit Conditions menu appear.'

14-3: Edit Conditions

This menu will allow you to select any objects or targets in the selected phase.

12. Select the “+” to the left of Enemy Military Equipment to expand the section.

13. Select the A-50.

14. Select the box to the right of “How many” and write in the number 1.

15. Select OK. The Edit Conditions menu will close.

16. Repeat steps 11 and 12 above.

17. Select the MiG-29.

18. Select the box to the right of “How many” and write in the number 0.

19. Select OK. The Edit Conditions menu will close.

20. The Phases menu will now show “Destroy 1 enemy A-50” and Destroy 0 enemy MiG-29 in the Condition lines window. You have now set the campaign to take the player to Phase 2 on the condition that the only enemy aircraft killed is the A-50.

21. Use the arrows to select Phase condition 2 of 2. The Condition line window will go blank and the Next Phase will show Phase 3.

22. Repeat steps 11 through 17.

23. Select the box to the right of “How many” and write in the number 1 (for the MiG-29).

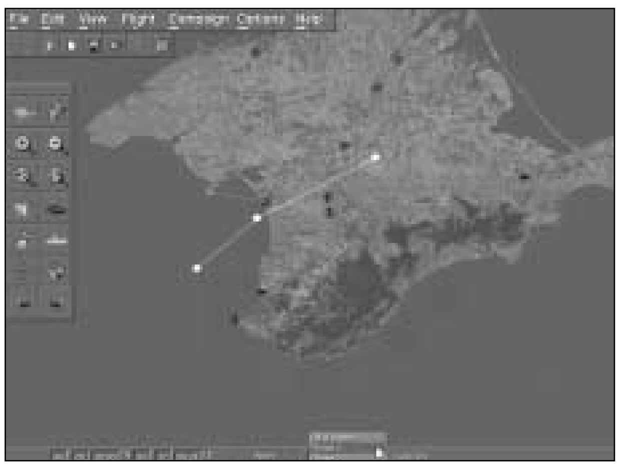
24. Select OK. The Edit Conditions menu will close.

25. The Phases menu should now show 2 lines:

Destroy 1 enemy A-50
Destroy 1 enemy MiG-29

You have now set the campaign to take the player to Phase 3 on the condition that the A-50 and the MiG-29 are destroyed.

26. Select and close the Phase menu and save the campaign.



14-4: Phase box

You will now need to adjust Phase 2 and 3 to fit the tasks and forces that were outlined above.

1. Select Phase 2 in the Phase box in the Status Bar at the bottom of the editor screen.

2. You should see the same exact objects and locations as in the Initial Phase.

3. Select the Ukrainian A-50 and delete it.

4. Set up the rest of the phase so that your airgroup and the MiG-29 fight.

5. Save the campaign.

6. Select Phase 3 in the Phase box in the Status Bar at the bottom of the editor screen.

7. Select all of the Ukrainian air forces and delete them.

8. Set up a mission with your aircraft (Anti-Ship Strike) attacking an Orel (Krivak-3).

9. Select the Initial Phase in the Phase box in the Status Bar at the bottom of the editor screen (When you save a campaign, it is saved to the phase that you had open at the time of the phase).

10. Save the campaign.

You have now successfully made a very simple campaign. The player would play the first phase and then, depending upon the outcome, move to the Phase 2 or Phase 3. If the player did not meet any of the conditions, then he would only be given the option of playing the Initial Phase again.

You can, of course, make as many phases and branches as you would like. You can (and should) make more detailed briefings, so the player knows exactly what his task is and what is expected of him to move onto the next phase. Good briefings also add to the game playing experience.

Now, if you want to refine the campaign even more, move onto the Mission Conditions section.

Mission Conditions

This allows the player to set the mission conditions within a phase. This allow you to create multiple possibilities within each phase as to the composition and location of forces, depending upon the results of the previous phase. Using the sample campaign built in the section above we are going to set Mission Conditions based upon whether the player’s wingman is destroyed or not.

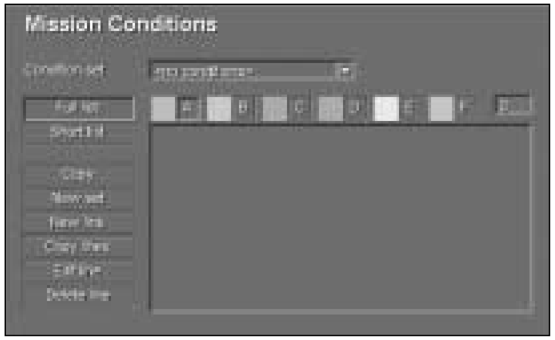
The campaign structure would look like:

RESULT FROM INITIAL PHASE	MISSION CONDITON	GO TO
Destroy A-50	Your Wingman survives	Phase 2: Fighter Sweep (you and your wingman) against the surviving MiG-29.
Destroy A-50	Your Wingman is destroyed	Phase 2: Fighter Sweep (Just you) against the surviving MiG-29. A Mig-23 is added to your side.
Destroy A-50 and Mig-29	Your Wingman survives	Phase 3: Anti-ship strike(you and your wingman) against an Orel (Krivak-3).
Destroy A-50 and Mig-29	Your Wingman is destroyed	Phase 3: Anti-ship strike (just you) against an Orel (Krivak-3). An Su-30 is added to your side.

As you can see, by changing one mission condition, we have doubled the possible situations that the player would be faced with following the Initial Phase.

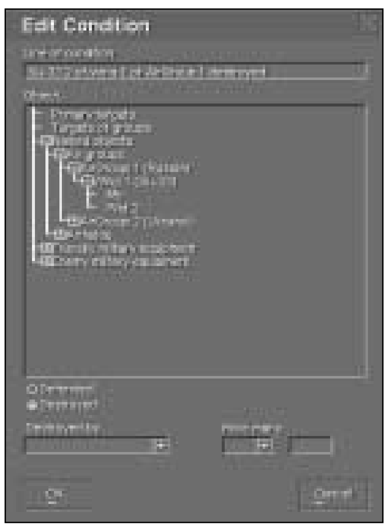
The steps to build in this mission condition is a follows:

1. Load the campaign built in the above section.
2. Select Phase 2 in the Phase box in the Status Bar at the bottom of the editor screen.
3. Select Campaign, Mission Conditions.



14-5: Mission Conditions menu

4. Press the New Line button. The Edit Conditions menu will appear.
5. Select your wingman under the Named Objects/Airgroups/Airgroup1 (if that is the name you gave that airgroup)/Wing1/Pilot2.
6. Select the Destroyed button at the bottom of the menu.



14-5: Selecting Your Wingman

7. Select OK. The Edit Conditions menu will close and you will see your wingman being destroyed appear on the Mission Conditions menu.
8. Repeat steps 4 and 5 above.
9. Select the Defended button at the bottom of the menu.
10. Select OK. The Edit Conditions menu will close and you will see that your wingman being destroyed and saved appear as conditions on the Mission Conditions menu.
11. Press the New Set button. Write in the Condition Set box “Wingman Destroyed.”
12. Press the New Set button. Write in the Condition Set box “Wingman Saved.”
13. With Wingman Saved showing in the Condition set box, select the “A”(red) button.
14. Select “Su-33 2 of wing 1 of Airgroup 1 saved.” The text should turn red.
15. Select “Wingman Destroyed” in the Condition set box by using the arrow to the right of the box.
16. Select “Su-33 2 of wing 1 of Airgroup 1 destroyed.” The text should turn red.
17. Close the Mission Conditions menu.
18. Select Phase 3 in the Phase box in the Status Bar at the bottom of the editor screen.
19. Repeat steps 3 through 17 above.
20. Save the campaign.

The Elementary Condition buttons (A (red), B (green), etc.) that appear on the menu, allow you to select the conditions as an AND (conditions in using one colour) or an OR (conditions in multiple colours) condition. Let’s say that the conditions that you choose (using the New Line button) in a phase were:

• Destroy the bridge

• Defend the E-3 AWACS

An AND condition would be created when you choose the Condition Set (in the Condition Set box), selected the A (red) button and then select both the “Destroy the bridge” and the “Defend the AWACS.” This would create the condition that the player would have to fulfill BOTH of the these conditions in order to complete this condition set.

To make an OR condition for a condition set, select the A button and then select the “Destroy the Bridge” condition. Then select the B (green) button and select the “Defend the AWACS” condition. This would mean that the player would have to Defend the AWACS OR Destroy the Bridge in order to fulfill the condition set.

You have now set the each of the conditions within Phase 2 to whether your wingman survives or is destroyed. You now need to change the forces to match the conditions set out above.

1. Select Phase 2 in the Phase box in the Status Bar at the bottom of the editor screen.

2. Select Campaign, Mission Conditions.

3. Select “<No Conditions>” in the Condition set box by using the arrow to the right of the box. You can only add objects when “<No Conditions>” is selected. Adding an object will add it to all of the conditions within this phase.

4. Add a MiG-23 to your side (Russian, fighter sweep).

5. Select “Wingman Destroyed” in the Condition set box by using the arrow to the right of the box.

6. Open the player’s airgroup and delete the wingman.

7. Select “Wingman Saved” in the Condition set box by using the arrow to the right of the box.

8. Select the MiG-23 (remember that it was placed in all conditions of Phase 2 when you placed it with “<No Conditions>” selected in the Conditions Set box).

9. Select Campaign, Remove Objects (Alt+Z). The Mig-23 will be deleted from this condition set only.

10. Close the Mission Conditions menu.

11. Select Phase 3 in the Phase box in the Status Bar at the bottom of the editor screen.

12. Repeat steps 2 and 3 above.

13. Add a Su-30 to your side (Russian, Anti-Ship Strike).

14. Repeat steps 5 through 7 above.

15. Select the Su-30.

16. Repeat steps 9 and 10.

17. Select the Initial Phase in the Phase box in the Status Bar at the bottom of the editor screen.

18. Save the campaign.

You have created the a simple campaign, with 4 possible follow-on phases, all dependent upon what happens in the Initial Phase. As you can see, the possible different combinations of forces, locations and outcomes that you can create is immense.

Contingency Planning

Contingency planning allows the player to review all of the objects in a phase the different condition sets.

CHAPTER 15

Multiplay

Defense Visual Information Center - Department of Defense

MULTIPLAYER GAME OVERVIEW

Flanker supports multiplayer gaming sessions over both IPX and TCP/IP (including via the Internet) networks. Flanker will support up to 32 players per multiplayer session; however, network bandwidth issues may further restrict the number of players. One player’s computer serves as a “host.” The host controls the overall progress of the game, providing updates to each “guest” machine. Generally speaking, the fastest computer with the highest speed network connection should play host.

HOST CONTROLS

As mentioned, the host is responsible for controlling the gaming session. The host not only configures and starts the session, but can also control who joins the session and even eject players from the game.

Establishing a Multiplayer Session

The host begins and configures the multiplayer gaming session.

1. Selecting the Mission Editor from the main menu. Edit the mission as desired.

Note:

It is advisable to set the Options, Skills to Allow for crash recovery. This is the only way that the Host can get back into the mission, without disconnecting. Once this is enabled, select the Recover button, instead of the Quit button when you exit the mission (Ctrl+Q). Also, remember to set the object density to the same setting for all players. Set any other options you would like at this time.

2. Select the “Flight” menu

3. Select “Network Play.” The network setup dialog box will appear.

4. Select “Host”

5. Change your name to reflect anything you wish; we recommend that the host set their name to “Host” to assist other players joining the session.

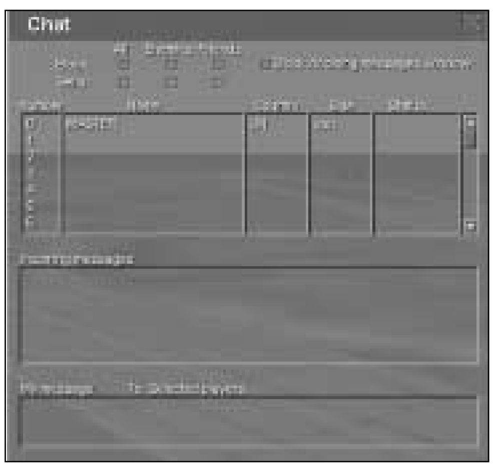
6. Select TCP/IP or IPX protocol. If you select TCP/IP, you must also select LAN (local area network) or WAN (Internet connection). You will also need to know your computer’s IP address. The program will provide you with your IP address when you select the Host button (You may also determine your computer’s IP address when you’re not running Flanker by selecting the Start menu, clicking “Run” and entering “winipcfg” in the dialog box. Winipcfg will report information about your network connection, including the IP address).

7. Select “OK.”

8. Make any last minute alterations to the mission.

9. Select the “Flight” menu.

10. Select either “Start Mission” or “Record Track” (if you want to save a .TRK file of this mission)



11. You will be placed in the cockpit of your aircraft with the world frozen. You may switch views (only when the message panel is closed), send messages via the chat window, and wait for other players to connect. After all players have joined, press the S key to un-pause and start the session.

Player Control Panel

Only the host has access to the Player Control Panel. Activate the panel by pressing CTRL-N. The panel will show currently connected players, indicating whether they are inflight or still initialising, and their network address, and their blocking status.

Removing Players

There are several reasons to remove players from gaming sessions. During competition play, the host may eliminate players who have been disqualified. The host may also eject players for unsportsmanlike or undesired behavior. To remove a player, activate the Player Control Panel, select the appropriate player, then click the “Close Connection” field. The value will change from “connect” to “close.” Click the “Apply” button to remove the player.

Blocking Connection Attempts

The host can block repeated connection attempts by undesired players. Activate the Player Control Panel, select the appropriate player and click the “Block Connection” field. The field will change from “not blocked” to “blocked.” Click “Apply” to enact the change. Once blocked, a player cannot be un-blocked during that gaming session. Up to 32 addresses can be blocked in a single session.

GUEST OPTIONS

Guests are any players joining a session created by a host. Guests may not control the status of other players, but they may control what messages they receive from other players.

Joining A Multiplayer Session

To enter a game as a guest, use the following steps:

1. From the main menu, enter the Mission Editor.

2. Press cancel when prompted to choose a mission.

3. Select the "Flight" menu.

4. Select "Network Game."

5. Select "Client" when the networking dialog box appears.

6. Choose either IPX or TCP/IP protocol. If using TCP/IP, you'll need to enter the Host's IP address as well.

7. You should connect to the host within 30 to 45 seconds, depending on network conditions.

8. You will be returned to the mission editor. You may add your own "fragment" to the mission, but you may not edit other's fragments. Simply create your airgroup with loadout, route, etc.

9. Select the "Flight" menu.

10. Select either "Start" or "Record" (to save a .TRK file of the mission).

11. You will be placed in the cockpit with the world frozen until the Host presses the S key. You may send messages via the chat window in the meantime.

MESSAGE EXCHANGE PANEL

The Message Exchange Panel lets individual users send and receive messages to each other. Guests may not control the status of other players (only the host can do that) but guests can configure who they can communicate with. All players, including the host have access to the Message Exchange Panel. Activate the panel by pressing CTRL-M.

Sending and Receiving Messages

To communicate with other players, open the Message Exchange Panel (Ctrl+M). Click on the panel or press TAB until "My Message" is the active window. Type your message (up to 128 characters), then press ENTER to transmit it.

The panel displays the last five messages you've received. If you receive a message while the panel is closed, you will receive an incoming message alert in the upper right corner of the screen. You may view the message by activating the panel. This alert may be disabled by selecting the "Block Incoming Message Window" checkbox on the Message Exchange Panel itself.

Communication Channels

A "channel" represents a communication connection between two players. A channel may have three states:

1. Receive – You may receive messages from the other player, but they have chosen not to receive messages from you.

2. Send/Receive – The channel is open in both directions and you can freely communicate with the other player.

3. Blocked – You've chosen not to receive the other player's messages. A guest may not block the host's messages although a host may choose to block any guest.

Changing Status With Filters

The upper left corner of the Message Exchange Panel contains a matrix of Block/Send status with three categories of players (All, Enemies, and Friends). You may choose to open or close the channel to any of these classes.

Changing Individual Channels

You may customise the channels on a player-by-player basis. The filters described earlier override any individual settings, so you must first set all filters to "Send" status. Next select each individual player and click on the status field to cycle through "receive," "send/receive," and "blocked" status. If any new players join the game, you will need to adjust their message status accordingly. Altering any global filter will override any individual settings.

DISCONNECTING

Press CTRL-Q at any time to disconnect. You'll be removed from the gaming session and placed in the Mission Editor. You cannot re-establish the connection without starting a new session (as a host) or joining an existing session (as a guest).

CHAPTER 16

Understanding SAMs And Countermeasures

Defense Visual Information Center - Department of Defense

Although our program is an aircraft simulation, you will soon find that not only enemy aircraft haunt you. Both Russian and Ukraine air defense (PVO) units, PVO Ground Forces and Navy have extensive anti-aircraft artillery (AAA) and surface-to-air missile launchers (also known as SAMs or SAM sites) in service. Since AAA and SAMs play significant roles in modern air war, the pilot should be aware of what types of surface-to-air weapons he might come across and how to counteract them.

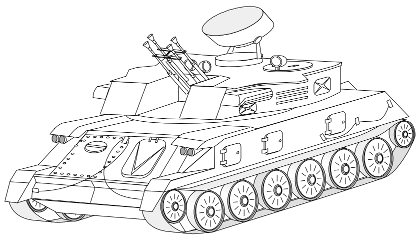
ANTI-AIRCRAFT ARTILLERY

In general, AAA is effective against low-flying targets and mainly serves for covering troops from enemy aircraft. Many armies have multi-barreled mobile AAA systems fitted with radar and a fire control system that provide effective operation in any meteorological conditions. In distinction to Ground Forces, shipborne artillery usually has a multipurpose character and fighting against airborne targets is just one of their many functions.

An AAA shell consists of a warhead, an impact fuse that detonates at the moment of contact with the target, and a "time fuse" which detonates after a particular flight time. The target is generally destroyed by the fragments produced by the warhead on detonation.

AAA of Ground Forces

ZSU-23-4 Shilka



The ZSU-23-4 Shilka (pronounced 'shil-ka') is a cannon anti-aircraft system mounted on an armored tracked chassis. It has high off-road capabilities and is intended for destroying low-flying airborne targets while static or in motion and in all weather conditions.

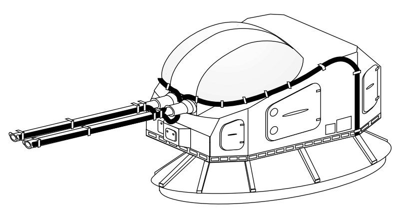
The armament of the Shilka consists of four 23-mm cannons mounted on a rotary turret. The effective range is 2500 meters for targets flying at altitudes up to 1500 meters. The fire rate is 3400 rounds per minute (rpm). The onboard ammunition pack contains 2000 rounds.

To search for airborne targets, the Shilka normally employs continuous-wave radar that can detect a typical target at a range of 20 km. Under conditions of ECM, the Shilka can detect and track targets with an IR sight.

Shipborne Artillery Systems

To destroy low-flying airborne targets, battleships use multipurpose guns that can also be used against enemy ships and coastal defense. For the most part, shipborne artillery is classed as 100-130-mm guns (heavy caliber), 57-76-mm guns (medium caliber) and 20-40-mm guns (small caliber). All guns have a high degree of automation of aiming, loading, and firing.

A heavy or medium caliber multipurpose artillery system is highly automated and capable of operating in very rough seas and in any weather. Such systems consist of two major parts, one of which is located above the deck, the other below the deck. The below deck part contains ammunition, shell lift, control posts and so on. The above deck part consists of a rotary turret with one or more barrels. Against airborne targets such guns use shells with blast-fragmentation warheads and radio proximity fuses detonating in the vicinity of the target. The effective range of a heavy gun is about 20-25 km. Its altitude range is 10-12 km and fire rate is 35-60 rpm. Medium caliber guns have significantly higher rates of fire from 400 to 500 rpm and effective ranges of 10-13 km.



Automatic small-caliber (20-40 mm) anti-aircraft guns are mainly effective as a means of defense against low-flying aircraft and cruise missiles. Since SAMs normally have a substantial dead area, within which airborne targets cannot be hit, ship-borne AAA should be used in such cases. Indeed, if a low-flying target has been detected close to the ship, the systems usually have time to launch no more than one SAM. Furthermore, the efficiency of launching a SAM at a target flying above water surface at an altitude of 5-15 m is low due to sea clutter. That is why, to destroy targets that have broken through air defense, the ship uses multi-barreled high firing rate AA guns having a fire rate of about 1000 rpm per barrel. 30-mm guns have an effective range of 5000 meters; however, range is less important than rate of fire and density of fire.

The operator controls fire using targeting information from the shipborne systems. Such systems include radar for detecting and tracking targets and a fire control system that computes the collision point and controls barrels in horizontal and vertical planes. The barrels are aimed automatically at an angular rate of 40-70° per second, which allows high-speed airborne targets to be hit at close range and heavy ship roll and pitch. A typical shipborne artillery system (the AK-725) is shown in the figure.

The table below presents specifications of the most widely used shipborne automatic artillery systems:

Type	Caliber, mm	Class	Fire rate, rpm	Range, km
AK-130	130	2-gun	35	29
AK-100	100	1-gun	60	21
AK-726	76.2	2-gun	400	13
AK-176	76.2	1-gun	500	10
AK-725	57.0	2-gun	400	13
AK-630	30.0	6-barreled	5000	5
AK-230	30.0	2-barreled	2100	6
AK-306	30.0	1-barreled	1000	5

UNDERSTANDING SAM SYSTEMS

Surface-to-air missile

The main elements of a SAM (airframe, guidance system, fuse, warhead, and rocket motor) are similar in design and functions to those of AAMs. In addition, aerodynamic control of some types of SAMs can be complemented by exhaust-deflector vanes.

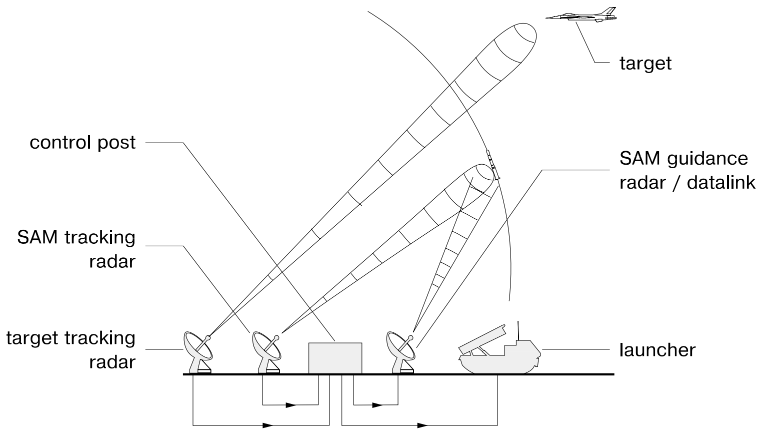
The flight trajectory of a SAM, as well as the composition and principle of operation of the autopilot are governed by the guidance method employed. The autopilot on its own or with the help of ground facilities continuously calculates relative positions of the SAM and the target and provides commands to the control surfaces.

Guidance for SAMs can be classified as one of the following: command, beam-rider guidance, homing (active, semiactive and passive), and combined guidance.

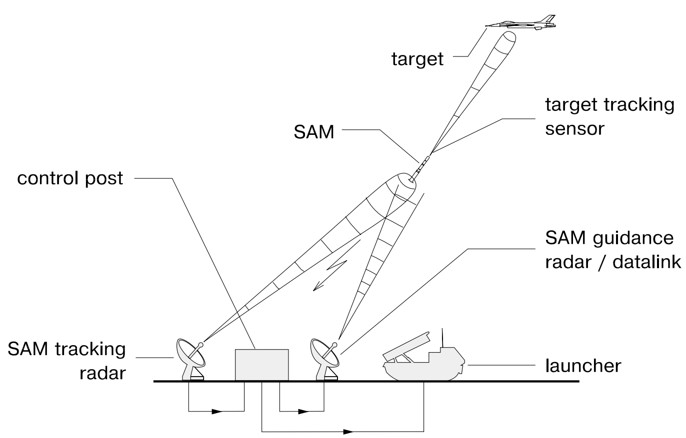
Command guidance

Command guidance may be compared to classic remote control. During the SAM's flight the positions of both the target and the missile are monitored from the ground or by the missile's onboard equipment.

If a SAM is guided by the ground facilities (see the figure below), the latter are responsible for detecting the target, measuring its coordinates and those of the SAM. After processing the coordinates the control post forms encoded guidance instructions and transmits them to the missile by radio data link, which is susceptible to jamming. After decoding by the missile's onboard equipment the commands are sent to the autopilot. This type of command guidance is normally employed in short-range and medium-range SAM systems such as the Tor (SA-15) or Osa (SA-8 'Gecko'), since the guidance accuracy decreases as the range increases.

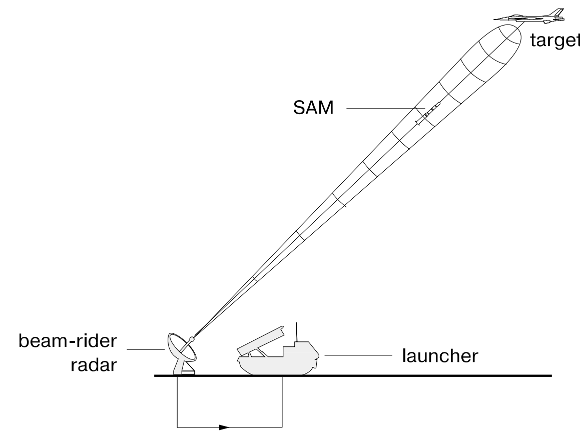


If the SAM itself can track the target, it measures and processes the parameters of the target's motion and sends them to the control post through radio data link. The coordinates of the SAM itself are measured by a ground-based tracking radar. Again, after comparing co-ordinates of the SAM and of the target, the control post sends guidance commands to the SAM. In systems of this kind the guidance accuracy does not depend on range, however, the onboard equipment is more sophisticated. Long-range SAM systems such as the S-300 (SA-10B ''Grumble') usually employ this type of command guidance in mid-course.



Beam-rider guidance

Beam-rider guidance is somewhat similar to command guidance along the line of sight between the target and the tracking radar, except that the missile guidance system is designed to seek and follow the center of the guidance beam automatically, without specific correction instructions from the launching platform. The guidance beam is provided by a ground-based target tracking radar, and it "highlights" the direction to the target. Like command guidance systems, beam-rider SAM systems are not limited to daylight and good-weather conditions.



One problem with beam-rider systems, as with command ones, is that the SAM must have high manoeuvreability in order to intercept an evasive target. As they approach the target, beam-rider missiles often must tighten their turns continually to keep up. At high speeds tight turns may exceed the missile's capabilities. Using two radars, one for target tracking and a second for missile tracking and guidance, can reduce this problem somewhat by providing a more efficient lead trajectory. Beam-rider guidance is usually more accurate and faster-reacting than command guidance systems.

Homing

The most effective type of guidance against evasive targets is homing, when the missile guidance system gets information about the target and produces control commands on its own. Thus, the control post does not guide the SAM.

For active homing the SAM illuminates the target and receives the signals reflected off the target. In the case of semiactive homing, the source of illumination (tracking radar) is located at the control post, and the SAM again gets signals reflected from the target. Passive homing systems use heat or light energy emitted by the target to estimate the parameters of the target's motion. This kind of homing is implemented in the Strela-10 SAM system (SA-13 'Gopher').

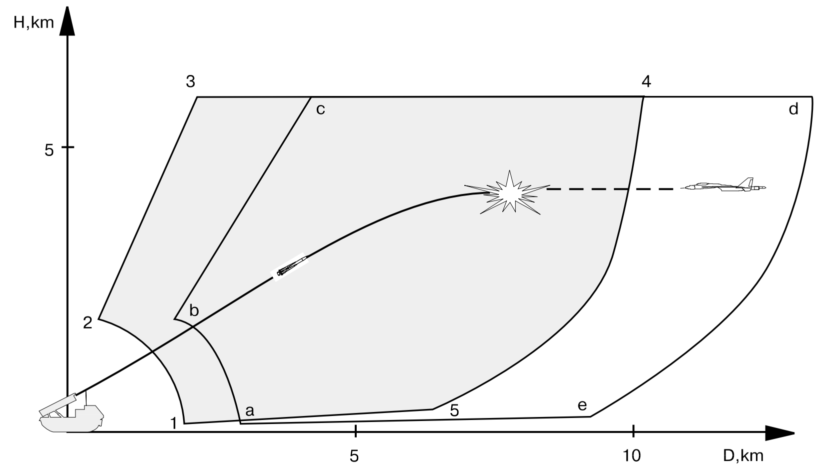
In general, homing systems operate in the following way: while the SAM rests on the launcher its seeker is locked onto the selected target, the parameters of the target's motion being measured. After launch the SAM seeker tracks the target, estimating the tracking error and produces control commands independently from the ground.

Combined guidance

The Kub (Cube) SAM system (SA-6A 'Gainful') is an example of a system with combined guidance. This system employs radio command guidance on the initial part of the missile trajectory and homing when closing in on the target. This provides high accuracy at long range.

SAM engagement envelope

The performance of a SAM system mainly depends on its engagement envelope, within which the system tracks and hits airborne targets with a given probability (the grey area 1-2-3-4-5 on the figure below). A typical engagement envelope is limited by maximum and minimum launch ranges and altitudes. The more central the target to the envelope, the higher the kill probability. Note that if we consider a moving target the envelope shifts as shown in the figure (the a-b-c-d-e area). This means that the missile can be launched even if the target has not yet entered the SAM engagement envelope but is closing in to it.



Typical SAM engagement envelope

The position of the upper and right boundaries of the envelope mainly depends on the energy capabilities of the SAM and quality of its tracking system and autopilot. This boundary defines the altitude and range to the collision point providing engagement effectiveness not less than a given threshold. Since the SAM trajectory depends on target speed, altitude, and course, the position of the envelope boundary is calculated for a particular given speed of the target.

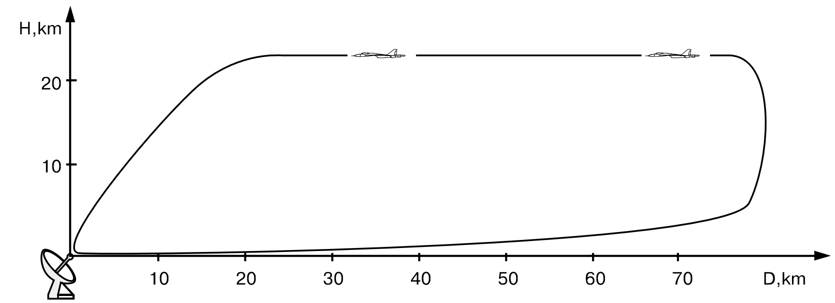
Maximum effective range of the tracking system is governed by the target effective reflection area and altitude and may vary substantially. If for a certain target the effective range of the radar is less than that of the SAM, this will decrease the engagement envelope. The effective range is the primary characteristic of any SAM system, so we can classify SAM systems as follows:

- Long-range SAMs (> 100 km).
- Medium-range SAMs (20 to 100 km).
- Medium-and-short range SAMs (10 to 20 km).
- Short-range SAMs (< 10 km).

The position of the lower boundary of the engagement envelope depends on the radar's ability to detect and track low-flying targets and on the ability of the SAM to fly at low altitude without crashing into the ground. Besides, the proximity fuse should not mistakenly detonate near the ground by confusing the latter with a target.

Many factors such as curvature of the ground surface, reflection of radio waves from the ground, and ground clutter, limit the possibility of detecting a low-flying target. Ground curvature limits the line-of-sight range, which affects operation of long-range and medium-range SAMs. Indeed, if a radar antenna is located at ground level, then the radio horizon dip is about 20 meters at a distance of 20 km and 150 meters at a distance of 50 km. The dip of the radio horizon increases proportionally with the square of distance. This means that it will be impossible to detect a target flying at an altitude of less than 150 meters while at a distance of 50 km. Lowering the radar beam will not help as it will only create further ground reflected interference which further reduces range.

The figure below shows a typical antenna radiation diagram as a function of distance and altitude.



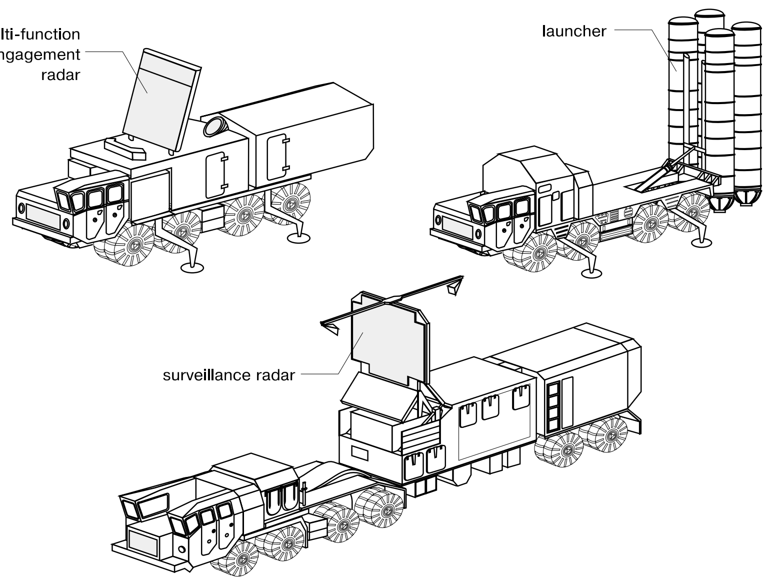
Radar antenna pattern

Furthermore, at low altitudes it is relatively difficult for radar to discriminate between target returns and returns from local objects such as towers, moving heavy goods vehicles, etc. Reflection intensity of local objects may vary depending on their material, size, shape, surface smoothness, etc. Consequently, returns from local objects depend on the specific operating conditions of the radar. These returns may lead to errors of measurement of angular position and range to the target, which will adversely affect the quality of guidance and may break the target lock.

To aim a SAM at a certain point, most SAM launchers are equipped with horizontal (for azimuth angles) and vertical (for elevation angles) mechanisms. Such SAM launchers are called rotary. This makes it possible to launch the SAM in the optimal direction hence reducing an initial vectoring error and bringing the near boundary of the SAM envelope closer. Modern SAM systems also use vertical launchers which permit simultaneous multi-direction launches.

Long-range SAMs

S-300PMU



The multi-channel mobile S-300PMU (SA-10B 'Grumble') was designed by the Grushin and Raspletin OKB and entered service in 1985. The S-300 serves for covering cities and industrial installations from enemy air raids, defending stationary control posts located in tactical depth. The system has a short reaction time, high degree of automation, and high firing capabilities (3 seconds per launch). It can simultaneously track 9 targets and independently fire at 6 targets, one or two SAMs to each. The S-300PMU can hit targets flying at speeds of up to 10000 km/h at altitudes from 25 to 30000 meters and has a guaranteed effective range of 90 km.

The system consists of the 64N6E 'Big Bird' phased array surveillance radar, the 36N6E 'Flap-Lid' phased array multi-function engagement radar capable of tracking stealth targets. The control post can manage up to 12 self-propelled launchers each carrying 4 SAMs. The 'Flap-Lid' radar rests on a single four-axle chassis with high off-road capabilities.

The S-300 launches SAMs in the upright position, which enables it to fire at targets approaching from any direction. This gives the system big advantages in conditions of intensive manoeuvreing combat as this eliminates the necessity of turning the launchers beforehand to cover all directions.

The system employs the 48N6E SAM. It is a single-stage solid-propellant missile effective against any airborne targets (aircraft, helicopters, tactical and cruise missiles) at medium ranges in wide altitude limits. The 48N6E is fitted with a 143-kg blast-fragmentation warhead. The SAM blasts off upright from the launching container with a catapult to an altitude of 20-25 meters, then the rocket motor ignites. Blastoff acceleration may be as high as 100 Gs allowing the SAM to quickly pick up speed, which can reach 7500 km/h. In flight the 48N6E is controlled by exhaust deflector vanes and ailerons.

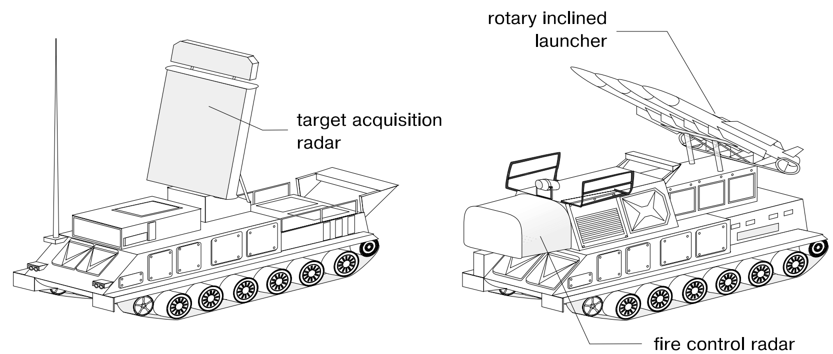
The S-300PMU employs inertial guidance in mid-course with commands from the 36N6E engagement radar and in the terminal phase semiactive track-via-missile mode. The 36N6E radar illuminates the target and the missile's onboard passive radar seeker receives a reflected signal. The SAM then relays this signal through an ECM-resistant data link to the control post computer. The control post then transmits control commands to the SAM. Such a method allows one to fit the 48N6E SAM with light and relatively cheap equipment and at the same time to use high-performance signal processing ground facilities.

Rif

The shipborne version S-300F Rif (Reef) with USA/NATO designation SA-N-6 'Grumble' is intended for defending ships from enemy aircraft and cruise missiles. The S-300F is effective against manoeuvreing and sea-skimming targets. The SAMs blast off upright through launching hatches from the below-deck revolver-type launcher. The ammunition of the Rif may consist of 48 or 64 SAMs. This system is installed on the Slava class cruisers in 8 cell rotary launchers.

Medium-range SAM systems

Buk



The Buk (Beech, pronounced 'book') ground force SAM system (SA-11 'Gadfly') is designed by the Novator OKB and is effective against fast and agile aircraft, helicopters, and cruise missiles in conditions of massed air raids and intensive ECM. The Buk can simultaneously attack up to 12 targets flying at speeds up to 3000 km/h at ranges from 3 to 32 km and at altitudes between 15 and 22000 meters. The system reaction time is 8-10 seconds.

The Buk system has high mobility and combat survivability and consists of one control post, the 9S18 target acquisition station (NATO designation 'Snow Drift') and up to 6 self-propelled launchers. The phase array radar antenna of the target acquisition station is capable of detecting targets at a range of up to 100 km. Besides radar, the station has an IFF interrogator and a TV-optical sight. After the control post receives target acquisition information, it distributes detected targets by degree of danger: the most dangerous targets are assigned to available launchers. Using information from the control post or acting independently, the launcher's fire control radar (NATO designation 'Fire Dome') acquires a target and locks onto it at range of 70 to 85 km.

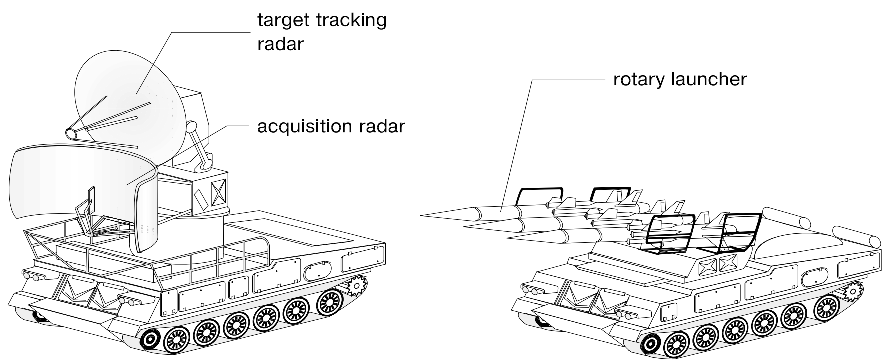
The Buk employs the 9M38M SAM with a single-stage solid-propellant rocket motor, semiactive radar seeker, radar proximity fuse, and 70-kg warhead. The SAM normally flies at Mach 3. Each launcher transports 4 SAMs which blast off from the rotary inclined launcher and hit targets with a kill probability of 0.7 to 0.9.

Besides the self-propelled launchers, the Buk can launch SAMs from 6 loading mounts (not shown in the figure on previous page) intended for transporting, loading, unloading and launching the SAMs. The mount normally carries 8 SAMs.

Shtil

The shipborne version of the Buk under the name of Shtil (Still) and USA/NATO designation SA-N-7 'Gadfly' is intended for air defense of both groups of ships and single ships against simultaneous attacks of anti-ship missiles and aircraft from several directions. The system operates in conjunction with the ship's 360° surveillance radar and has built-in TV-optical sights. The SAM (unified with that of the Buk) blasts off from a rotary launcher with higher launch rate. The Shtil has several modifications and can simultaneously engage up to 12 targets.

Kub



The Kub (Cube, pronounced 'koob') ground-based SAM launcher (USA/NATO designation SA-6A 'Gainful') and the shipborne Shtorm (Storm) with USA/NATO designation SA-N-3 'Goblet' are SAM systems of the previous generation. The Kub entered service in 1967 and is effective against airborne targets at altitudes of 50-12000 meters and at ranges of 3.7-24 km. The system includes the 1S91 'Straight Flush' acquisition and tracking radar supplemented by a TV-optical sight having with effective range of 20 km.

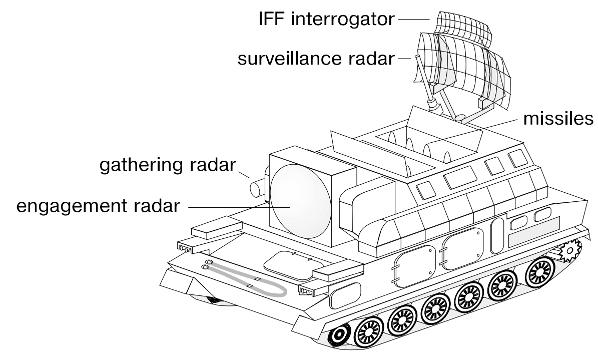
Besides the radar, the Kub system includes four rotary launchers with three 3M9M3 SAMs on each. The SAM is fitted with a 60-kg warhead, able to fly at a maximum speed of Mach 2.8 and employs combined radio command guidance with semiactive radar homing.

Shtorm

The Shtorm (Storm) shipborne SAM system (SA-N-3 'Goblet') was designed in the late 1960s for air defense and does not have an analogue in ground forces. The system consists of a rotary launcher with two ready for launch SAMs and an antenna post. The Shtorm employs the 4K60 SAMs intended for destroying airborne targets at altitudes of 100-25000 meters and at ranges of 3-55 km. The SAM is fitted with a 80-kg warhead, able to fly at a maximum speed of Mach 3 and employs radio command guidance. The Shtorm system is installed on the Moskva class aviation cruisers.

Medium-and-short range SAM systems

Tor



The Tor (Torus) (USA/NATO designation SA-15 'Gauntlet') is a mobile SAM system designed in 1988 by the Fakel OKB. The Tor can destroy enemy aircraft, helicopters, precision guided missiles, cruise missiles, guided bombs, and remotely piloted vehicles.

The unified tracked mount carries 8 SAMs on vertical launchers, a high-performance computer, a 'Dog Ear' surveillance radar and a phased-array engagement radar, which has an effective range of 25 km and can simultaneously detect 48 targets and track 10 targets, and a fire control radar which can simultaneously guide two SAMs. A small dome-type antenna on the top left of the engagement radar may 'gather' the missile as it is launched and hand it over to the engagement radar. The system reaction time is 5-8 sec.

The Tor employs the Fakel 9M330 SAMs with radio command guidance. The SAMs are stored and launched upright from the transport containers. After leaving the launcher, the SAM executes a corrective turn to the combat course using nose exhaust nozzles. Then the rocket motor ignites. The 9M330 has a maximum speed of 3000 km/h, maximum G-load of 30 Gs, an effective range of 1-12 km, and altitude limits of 10-6000 meters. The SAM can hit targets flying at speeds from 36 to 2500 km/h. The blast-fragmentation 15-kg warhead forms fragments having high penetration capabilities.

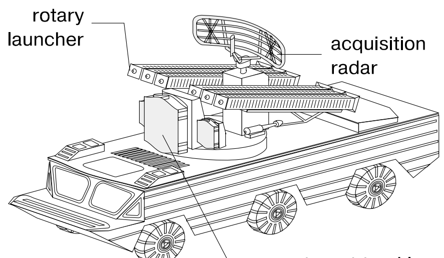
Klinok

The Klinok (Blade) (USA/NATO designation SA-N-9 'Gauntlet') is an autonomous all-weather shipborne SAM system intended for self-defense of military and civilian ships from massed attacks of low-flying antiship missiles, piloted and pilotless aircraft flying at low and medium altitudes. The system is installed on the Udaloy class destroyers and can simultaneously hit up to four targets.

The system has autonomous equipment for target acquisition providing independence from the ship's radar. It can detect targets at a range of about 45 km. The built-in TV-optical target tracking system has a range of 20 km and increased ECM-resistance in conditions of intensive countermeasures.

The below-deck launcher has several revolver-type launching modules. Each module houses 8 SAM containers. The ammunition complement may include 24-64 SAMs depending on the number of launchers in the system. The system employs SAMs similar to those of the Tor and having similar performances. The SAMs are launched upright using a catapult. On exit from the launcher, the nose exhaust nozzles vector the SAM to the target.

Osa-AK



The Osa-AK (Wasp) ground SAM system (SA-8B 'Gecko') and the Osa-M shipborne SAM system (SA-N-4B 'Gecko') are medium-range SAM systems of the previous generation.

The Osa-AK ground-based SAM system was designed by the Grushin OKB, entered service in 1980 and is intended for defending installations from guided missiles, guided bombs, aircraft, and helicopters. The Osa-AK has an effective range of 1500-10000 meters and can hit targets flying at a maximum speed of 1800 km/h at altitudes of 25-6000 meters. The whole system with its ammunition complement (six 9M33M SAMs in rotary launching containers) is mounted on a three-axle amphibious chassis with high off-road capabilities. The Osa-AK systems are usually combined into batteries of four launchers in each.

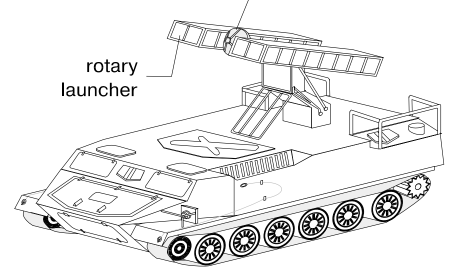
The system's 'Land Roll' radar is capable of detecting a typical target at a range of about 25 km. Besides radar, the Osa-AK is fitted with an optical sight assuring target tracking in conditions of ECM. The sight can track a target at a range of up to 20 km.

The Fakel 9M33M missile is fitted with a 40-kg warhead and a single-stage solid-propellant motor allowing it to travel at a maximum speed of Mach 2.5. The SAM employs radio command guidance. Probability of target destruction by one SAM depends on the target type and ranges from 0.4 to 0.95.

The Osa-M shipborne version has performances similar to those of the Osa-AK system. It is designed for self-defense of military and civilian ships from attacks of enemy aircraft flying at low and medium altitudes. The system consists of a rotary launcher with two ready-for-launch SAMs and an antenna post allowing it to operate autonomously. The Osa-M can also operate with targeting data from the ship's radar.

Short-range SAM systems

Strela-10M3



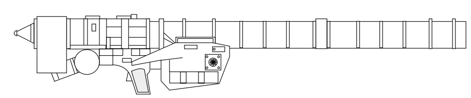
The Strela-10M3 (Arrow) light ground-based SAM system (SA-13 'Gopher') is intended for close-in troop protection from low-flying aircraft and helicopters, as well as for destroying cruise missiles and remotely piloted vehicles.

The Strela-10M3 is mounted on an amphibious armored tracked chassis and includes four ready-to-launch 9M333 SAMs in containers on a rotary launcher. The radar operates in common with the missile seeker, which employs double-channel homing by photo contrast and IR target emission.

The Strela-10M3 also includes an IFF interrogator and a passive radio direction finder intended for detecting and finding precise directions to airborne targets flying with enabled onboard radio equipment.

The 9M333 SAM is fitted with a 4-kg warhead and a single-stage solid-propellant rocket motor, which allows it to travel at an average speed of 1800 km/h. The SAM can hit airborne targets at ranges of 50-5000 meters and at altitudes of 25-3500 meters.

Igla

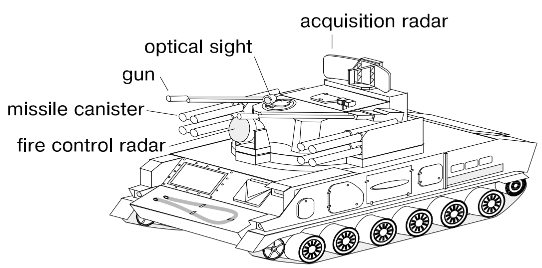


The Igla (Needle) portable SAM launcher (SA-16, 'Gimlet') designed by the Kolomna Machinery Design Bureau serves to defend small subunits, individual vehicles (tanks, infantry vehicles, self-propelled artillery mounts), small ships, and auxiliary vessel from air strikes. The Igla is intended for single shot launching from the shoulder. The shipborne version under the name SA-N-10 may use a quadruple launcher.

The Igla employs the 9M39 missile is fitted with a 1.2-kg warhead and a IR-homing system. The SAM allows one to down airborne targets flying at speeds of up to 1260 km/h at ranges of 500-5000 meters and at altitudes of 10-3500 meters. A single-stage solid-propellant rocket motor allows the SAM to travel at an average cruising speed of 2000 km/h. The target destruction probability is about 0.4.

Combined AA gun-missile launchers

Tunguska

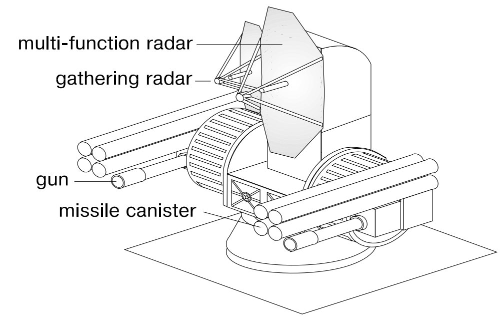


The Tunguska (SA-19 'Grison') system is a gun/missile complex. It is the world's first serial-production system which allows you to destroy targets both by missiles and artillery fire in all meteorological conditions both in daytime and at night. A typical Tunguska battery consists of six AA self-propelled armored mounts and maintenance equipment.

The Tunguska self-propelled mount includes a 'Hot Shot' radar, an optical sight, two automatic double-barreled 30-mm guns, and eight containers with the 9M311 SAMs. The AA guns having a total fire rate of 10000 rpm and muzzle velocity of 3500 km/h, provide an engagement envelope of 0-3000 meters for altitude and of 200-4000 meters for range. The guns can be employed from stationary position, during short stops, and in motion.

The 9M311 is a two-stage solid-propellant missile fitted with a 9-kg fragmentation/rod warhead and a proximity fuse with a fusing radius of 5 meters. The SAM has a maximum speed of 3200 km/h and an average speed of 2200 km/h. The 9M311 employs semi-automatic radio command guidance with manual target tracking and automatic placing of the SAM on the line-of-sight using signals transmitted through the radio data link. For SAMs, the system has an engagement envelope of 15-3500 meters for altitude and of 2500-8000 meters for range. The SAMs can hit airborne targets flying at speeds of 0-1800 km/h.

Kashtan



The Kashtan (Chestnut) shipborne gun/missile integrated weapon system (SA-N-11 'Grison') is designed by the Tula machine-building plant and intended for close air defense of ships of all classes (from gunboats to aircraft carriers). The system is effective against antiship missiles, guided bombs, aircraft and helicopters flying at ranges of up to 8000 m.

The Kashtan consists of launchers designed for eight 9M311 SAMs (similar to those used by the Tunguska), radar, a TV guidance system, and two multi-barreled 30-mm guns with a total fire rate of 10000 rpm. The 9M311 missile is fitted with a 9-kg warhead and employs radio command guidance.

The Kashtan can fire SAMs on targets at altitudes from 4000 meters to extremely low altitudes and at ranges from 1500 to 8000 meters. Operation of the system is completely automated and is capable of firing at up to six targets per minute.

EARLY WARNING SYSTEMS

Airborne warning and control system (AWACS)

AWACS aircraft provide constant surveillance of the current air situation over a very large area and give early warning to air defense units. A typical AWACS aircraft has a 360° all aspect radar and equipment for data processing and encoding. Such aircraft can collect and relay information about the air situation to ground (ship) command posts and guide interceptors to their targets. Furthermore, AWACS aircraft can be used to acquire ground (surface) targets and provide targeting data for strike aircraft.

The advantages of AWACS aircraft over ground (shipborne) radar include the ability to detect air borne targets flying at virtually any altitude, the ability to detect air borne targets flying at extremely low altitudes over the terrain with any relief, high mobility, and lesser vulnerability to various weapons. The main drawback of an AWACS aircraft is its long 'on station' patrolling role associated with its relatively high level of vulnerability, not to mention being a major focus of enemy attention.

A-50 AWACS aircraft

In early 1980s the Vega Scientific Production Association designed the Shmel (Bumble-bee) electronic complex. While being inferior to its American analogue E-3 AWACS in detection range and number of automatic guidance channels, the Shmel system effectively detects low-flying targets with small effective scattering area (cruise missiles, Stealth aircraft) and can relay highly encrypted data to practically any location via its satellite communication module. The system was installed onto IL-76MD transport aircraft by the Beriev OKB located in Taganrog. The AWACS aircraft was given the name A-50. The IL-76MD was chosen as the platform for the Shmel system due to its high airspeed (800 km/h) and radius of operation. The aircraft can patrol an area for up to 4 hours at 1000 km from base without refuelling. The relatively high cruise altitude (10000 meters) makes it possible to increase target detection range due to moving of the radio horizon, which equals 300 km at an altitude of 7000 meters, and 400 km at an altitude of 10000 meters.

The Shmel system of the A-50 includes a three-coordinate radar which measures target azimuth, range, and altitude. The radar antenna is housed in a 9 m fairing mounted above the fuselage. The radar detection range depends on the type of target and operational mode and can be as much as 400 kilometers.

The radar equipment of the A-50 aircraft provides long-range detection of airborne and naval targets, IFF confirmation, and guides aircraft of Air Force and Air Defense to the targets. Tactical crew of the A-50 consists of 10 people.

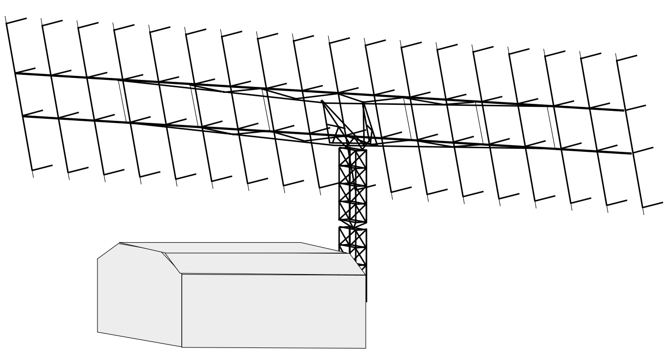
The A-50 has extensive ECM capability and combined chaff/flare cartridges, which provide defense from enemy fighters and ground-based antiaircraft systems.

During the Gulf War the A-50 aircraft flew patrol missions over the Black Sea and provided surveillance of the air space near the southern borders of the USSR. This allowed them to gather information about all fighters and transport aircraft which took off from Turkish airfields.

Early warning radar (EWR) stations

Tactical EWR stations are intended for target acquisition and designation, and provide radar information to SAM systems and air defense command posts.

1R13



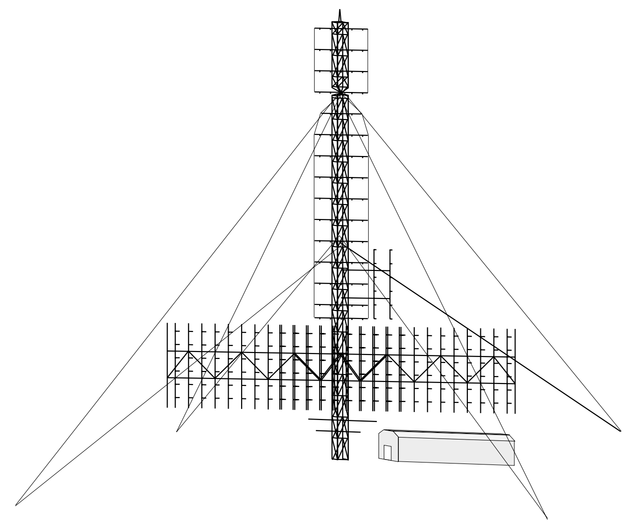
The 1R13 EWR station operates in the VHF wave band and can detect airborne targets and measure their co-ordinates (azimuth - range) at a long range in conditions of severe ECM. The system is capable of detecting the F-117A stealth aircraft. The 1R13 performs IFF confirmation and relays data to the command post through wire and radio data links.

The 1R13 radar measures the coordinates of targets in the entire range of azimuth angles at distances of up to 300 kilometers and elevation angles of up to 25˚. The maximum detection altitude for a target of the fighter class is 27 kilometers and a typical detection range for a fighter flying at high 10 kilometers equals 230 kilometers. The information is refreshed every 10 seconds.

The radar antenna array is mounted on a three-axle trailer. It can be deployed from travelling position within 45 minutes. The whole system consists of four automobiles.

55Zh6

The 55Zh6 EWR station is equipped with a three-coordinate radar operating in the VHF wave band. The radar is intended for detecting and measuring coordinates of modern and future aircraft, helicopters, cruise missiles, and aerostats in the conditions of severe ground clutter and ECM. The 55Zh6 system can operate both as a part of automated control systems and standalone.



The system includes a phased array antenna attached to a mast and measuring 16x3.24 meters. The deployment time of the system is 22 hours. The 55Zh6 can detect targets at distances of up to 500 kilometers and at elevation angles of up to 16˚ in any azimuth angles. The detection ceiling of fighter class targets is 40 kilometers and the typical detection range at an altitude of 10 kilometers is about 300 kilometers. The system measures target coordinates with an accuracy of 500 meters in range, 24" in azimuth, and 850 meters in altitude. It provides refreshed data every 10 seconds.

MISSILE DEFENSE

Missiles, be it AAMs or SAMs, pose a serious threat to your aircraft. The philosophy of successful missile defense is based on the concepts of passive defense measures, which include avoidance of zones of potential threat, and active defense measures, such as ECM jamming, chaff and flares, and evasive manoeuvreing.

Passive defense measures

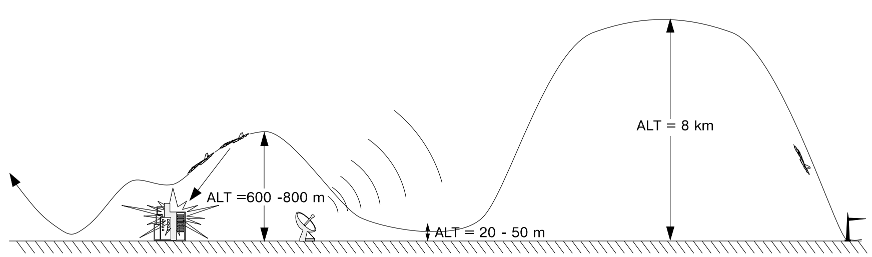
First of all, try to keep away from the areas of potential threat. Intelligence information may be provided to you at the mission briefing and/or in-flight, by AWACS. So, don't be hypnotised by the foretaste of the forthcoming combat, try to avoid being spotted. This can be achieved by flying at low altitudes or employing counter-radar manoeuvres

Keep a low profile

The Earth's curvature and terrain masking provided by hills, trees, etc., may limit the target acquisition range of SAM systems, which leads to a reduction of the time available to the enemy for effective air defense. Ground clutter is also a problem for radar-controlled SAMs, but unfortunately it can be reduced by Doppler techniques, phase array and alternative optical guidance systems.

Flying at extremely low altitudes (lower than the lower boundary of the SAM engagement envelope) theoretically excludes the possibility of being shot down. However, the pilot should take into account the greater effectiveness of small arms, AAA, and very short range SAMs, such as the Stinger or Igla portable SAM launchers. Within their operating envelopes most missiles can be expected to be more manoeuvreable at low altitude. Therefore, the faster you fly at low altitude, the less probability of being hit by AAA or short range SAMs due to an increase in target tracking errors.

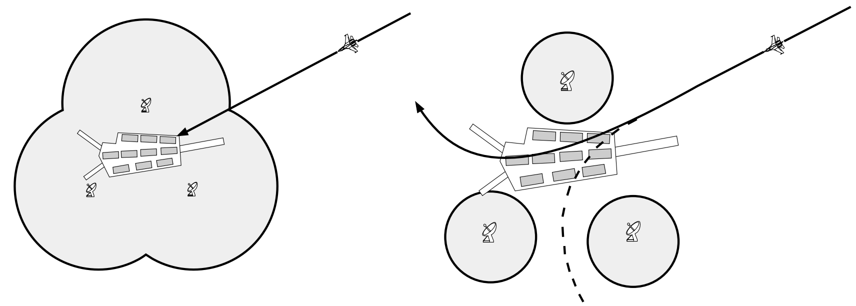
However, it should be noted that flying the plane at low altitudes requires increased attention and is very tiring. Low level operations may also limit the usefulness of the fighter's own weapons system. Because of this, you can use flight profiles with changing altitudes at various parts of the flight path. The figure below illustrates a typical mission profile Hi-lo-hi.



Hi-lo-hi mission profile

After the takeoff the aircraft climbs to 8 km to the point of potential detection by enemy air defense radars. Then the aircraft descends to an altitude of 20-50 meters and quickly passes through the radar detection zone while climbing to the altitude required for final reconnaissance and/or attack. In so doing, the fighter should employ ECM active jamming, chaff and flares if necessary.

Counter-radar manoeuvres are of vital importance before flying into detection areas. For example, a dive to low altitude discussed above is one of such manoeuvre. In the figure below you can see the combined detection area of three enemy radars for the aircraft flying high (left picture) and for that flying on the deck (right). As you can see, the low-flying aircraft in our case can get through the threat zone without risk of being detected.



Active defense measures

Passive measures are rarely 100% effective. Sooner or later the enemy will spot you. Once the Threat Warning Display (TWD) starts flashing and you hear the warning beep, it's time to get active and do something radical. To help you detect the enemy radars and missiles, the Flanker is equipped with the SPO-15 Radar Warning System (RWS) and Missile Launch Warning System (MLWS) - see Chapter 7 "Warnings and Failures".

The MLWS detects the missile launch and provides visual alarm sound beeps. The missile launch warning light '**ПУСК**' shows operation of the MLWS and means that a missile has been launched in the direction of your aircraft. Try to find out its range and most probable inbound trajectory. Should this missile be incoming within the sweep cone of your radar, the MFD will display the missile as an unidentified target symbol (small square).

As soon as you detect enemy radar painting your aircraft or a missile launch, you should execute a countermissile manoeuvre and employ countermeasures, which can be subdivided into two categories: jamming and deception (chaff and flares).

Evasive manoeuvreing

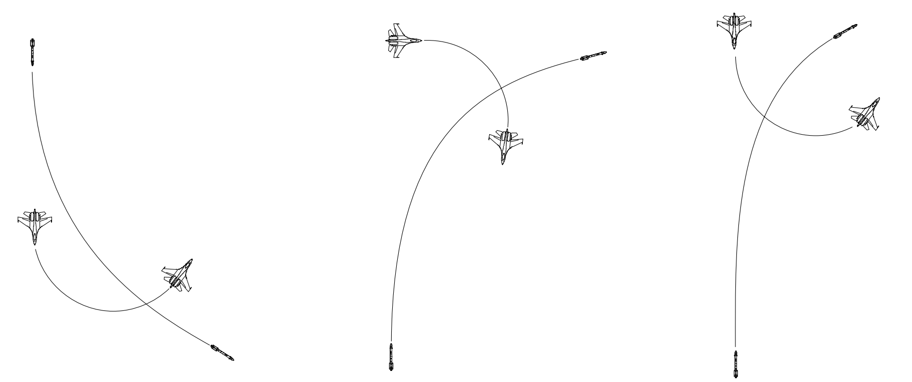
A counter-missile manoeuvre reduces the effectiveness of the missile's blast or completely outwits it avoiding any contact.

First, try to prevent the missile from being launched at all! Deny the enemy his required launch parameters, range, aspect, and aim. The more you know about your adversary's capabilities and limitations, the more effective your defensive tactics. Typically, this knowledge should include launch envelopes, aiming requirements, radar capabilities, and expected enemy tactics. In particular, counter-SAM manoeuvres may subject the aircraft to a dive, a steep half-spiral or fast change of course to the extent of turning in the opposite direction.

You should also take into account the fact that altitude has an important effect on missile range and effectiveness. In general, the range of both jet- and rocket-powered vehicles increases when they are operating at higher altitudes. Typically, missile range at 20,000 ft above mean sea level can be expected to be about double the sea-level value. However, the increased true airspeed of your aircraft at high altitudes will reduce the range of rear-quarter missiles and increase forward-quarter range.

Besides reducing the size of the missile's envelope, you can also fool the missile by generating line-of-sight (LOS) rates that exceed the missile's turn capability. The most effective counter-missile manoeuvre, which you can use against both SAMs and AAMs, is a break turn. There are several purposes for this break turn. One is to increase the LOS rate, making it more difficult for a missile to track and manoeuvre to an intercept. A second is to degrade seeker and guidance performance by moving the heat source away from a rear-hemisphere IR missile attack or by gaining a beam aspect against a radar missile. Attaining a beam aspect also may degrade fuse and warhead effectiveness. In addition, the break turn allows the earliest visual acquisition of the missile and/or launch platform. The direction of the defensive break turn depends on the aspect of the threat, and usually should be in the closest direction to achieve a beam aspect. For rear hemisphere missiles this generally means breaking towards the threat, and turning away from forward-hemisphere threats.

Lets illustrate how you can counteract to SAMs fired at your fighter from various aspects. To effectively execute a counter-SAM manoeuvre, you should first find out the location of the SAM site that is going to launch or has launched the SAM. On the Su-27 you can use the MFD for this purpose, which is showing a radar symbol, and the TWD, which will also show the type of enemy radar. Then you should choose the appropriate type of manoeuvre and direction of execution. Below are
a few counter-SAM manoeuvres for different relative aspect angles.



Counter-SAM manoeuvres

Jamming

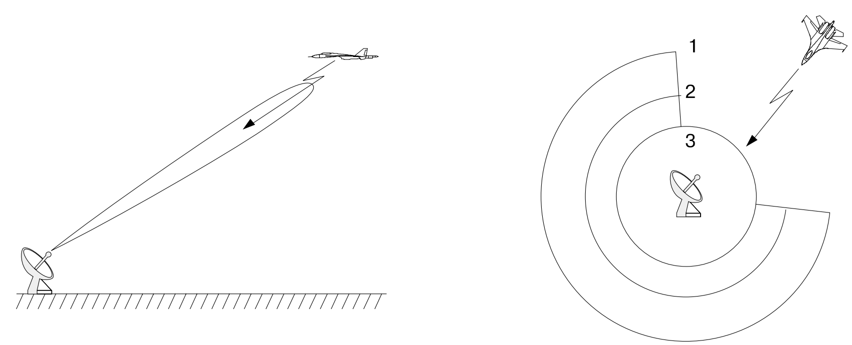
First of all, it should be noted that jamming can be passive or active. Passive jamming is designed to decrease fighter vulnerability to missile attack by using "camouflage" techniques. These include reducing the aircraft's radar reflectivity by using non-reflecting materials and radar-absorbing paint. Reflectivity is also sensitive to engine inlet design and placement, and to physical size and shape of various aircraft parts. IR signatures can be suppressed by using special jet-nozzle designs, by monitoring exhaust placement, and by adding chemicals to the exhaust. Even optical tracking can be made more difficult by using camouflage techniques that reduce the aircraft contrast with the background.

Active jamming (also called noise jamming) is created by the aircraft's own equipment or by a "stand-off jammer", which attempts to conceal other aircraft with its noise. The methods of active jamming may differ, but they are all based on producing a strong signal that will overpower the target return when it is received by the enemy radar. Besides jamming enemy radars, active jamming may also fool the missile seeker, fuse or command receiver.

The effectiveness of jamming is related to the ratio of the jamming power received by the enemy radar to the strength of the target's return. Since reflected target energy is much more sensitive to target range than is the received noise, active jamming is very effective at long distances. Noise is also more effective if it can be concentrated in a narrow beam at the enemy radar.

The ECM equipment transmits a continuous-wave signal that comes to the input of the enemy radar and suppresses the target returns. The most effective jamming signal which is difficult to filter is that modulated by white noise as its characteristics coincide with those of the receiver's own noise. Selective jamming has high power density; however, the jammer transmitter must be relatively accurately tuned to the frequency of the radar being jammed. This requires using corresponding intelligence-gathering equipment. Note that to jam a variety of radars, separate jammers should be used.

Sweep jamming has the advantage that one jammer transmitter jams all radars operating within a wide bandwidth. In this case the requirements of the intelligence-gathering equipment of the jammer are very moderate. However, the power density of sweep jamming is significantly lower than that of selective jamming, since the total power of a transmitter is spread over a wider frequency spectrum.



Selective (left) and sweep jamming (right)

In the figure above, the radar detection zone in the absence of jamming is marked by 1. In the case of barrage jamming the detection zone is smaller (2). And if the aircraft employs point-type (directional) jamming (3) it can close in to the radar at a maximum distance without being acquired.

Since for increased ECM-resistance many up-to-date radars operate with carrier frequency changing, *gliding (or quasi barrage) jamming* is the most efficient ECM against them. Gliding jamming covers a wide frequency band by quick frequency changes within a relatively narrow frequency band. This type of jamming does not require precise knowledge of the enemy radars operating frequency and is close to selective jamming by its high power density.

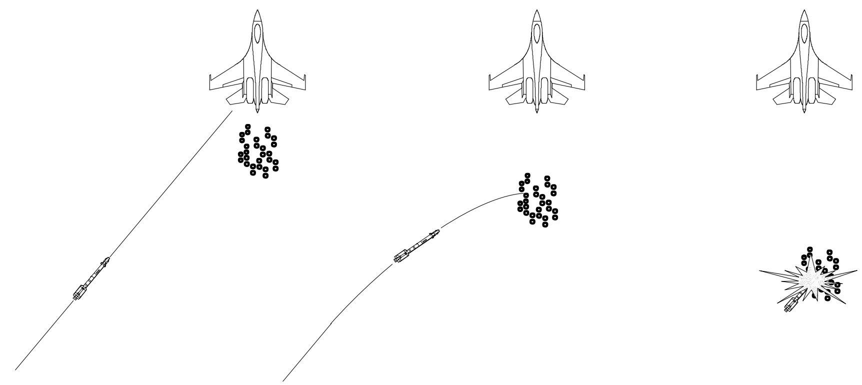
Deception jamming can imitate legitimate returns to the enemy radar, that is, to transmit the signal of the same frequency and duration as the target returns. This leads to "fooling" the enemy radar, since it "sees" spurious images or false targets at different ranges and azimuths. This complicates detection of real targets. Deception jamming may also mislead the enemy radar as to true range and speed of the target. This method of jamming is more effective than saturating a wide band of frequencies with noise, however, it requires that the jammer be matched exactly to the type of radar encountered.

We should note that regardless of the jamming form used there is one big drawback. The excess noise generated by the jammer makes it detectable at long ranges. Indeed, the jammer unmasks your aircraft. This means that if you turn on the jammer too early, that is, at a long range from the enemy radar, you increase the detection range, and the SAM will have additional time to prepare. Again, if you turn on the jammer transmitter too late, your aircraft may be shot down because SAM sites operate without hindrance. Therefore, using the jammer is a trade-off.

The active jamming equipment of the Su-27 normally includes a built-in onboard ECM pack, which provides the aircraft with self-defense from enemy airborne and ground-based radars. You can toggle the built-in jammer by pressing the **E** key. Operation of the active jammer is shown by the '**АП**' active jamming indicator on the instrument panel. To suppress enemy air defense radars during air-to-ground attacks or intercepts, the Su-27 can additionally carry the Sorbtsiya-S ECM system (analogue to the AN/ALQ-135 American jammer) installed into two pods on the aircraft wingtips. The system includes a receiver and a jammer-transmitter. It can detect and recognise illumination sources, and jam at an enemy frequency. If the enemy radar ceases operation, the jammer automatically turns off.

Deploying chaff and flares

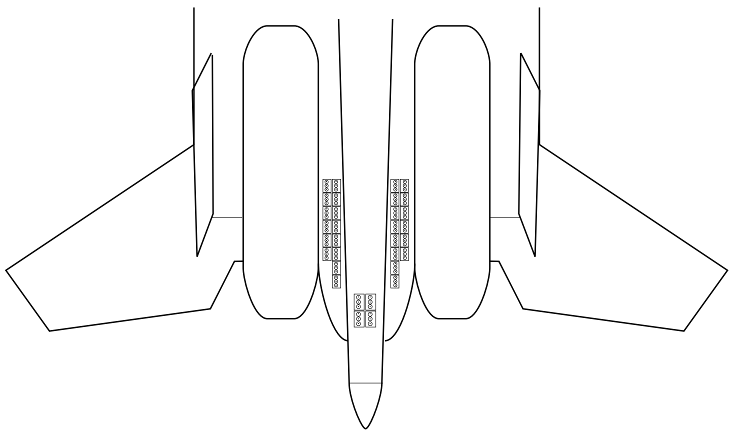
Deception countermeasures (DCM) involve generation of false targets and causing radars or IR seekers to lose the target. One of the earliest forms of deception DCM was chaff, generally large quantities of radar-reflecting material - narrow strips of glass fibre or nylon ribbon coated with metal. After being dispensed, chaff forms a cloud that reflects electromagnetic waves emitted by the enemy radar. This can break the lock on your aircraft or cause the missile radar seeker to relock onto the chaff cloud (see the figure below).



Chaff was used for the first time during WW II and showed itself as a cheap and sufficiently effective form of DCM. Effectiveness of DCM depends on the DCM resistance capabilities of the radar or missile seeker and on meteorological conditions (for example, strong wind may quickly disperse a chaff cloud). After being dispensed from a aircraft, chaff quickly decelerates, which leads to a significant difference in the speeds of the aircraft and the chaff cloud. This allows modern radars to recognise and ignore returns from the chaff cloud with relative ease.

Heated gases from the aircraft's jet engines (especially with the afterburners engaged) and the high temperatures in the combustion chambers provide reliable searching and tracking for IR-guided systems. The most widely used countermeasures against IR search and tracking equipment are decoy flares. Each flare is a small rocket that is fired upright and flies away from the aircraft to a distance of 100 meters or more (when fired on the ground). With a timely fired flare having intense heat point emission you may decoy the infrared guided missile launched at your aircraft. A decoy flare will burn only for a short time (about 10 seconds). It is recommended to dispense flares at a range of less than 10 km from the inbound missile when the IR emission of the flare is high enough for attracting the IR seeker. Simultaneously with flare deployment, you should make a break turn and cut the afterburners to avoid being locked again by the time the flares burn out. If you apply flares too early, the missile may ignore it or may have enough time to lock on your aircraft again when the flare has lost its effectiveness.

Unfortunately, modern missiles seekers can recognise flares decoys as well by analysing their intensity of emission and their rate of deceleration. So you must not put your trust in only passive countermeasures because you can only effectively fool the missile by using them together with active jamming and proper manoeuvreing.



To increase survivability, the Flanker is fitted with 51 upward-firing APP-50 chaff/flare dispensers, which are located in the tail boom (see the figure above) and contain 96 chaff cartridges or flares. The dispensers are deployed by pressing the **Q** key. In so doing, two decoy flares and one chaff cartridge are released. Applying chaff and flares simultaneously eliminates the task of deciding which type of the missile has been launched at your aircraft, radar or infrared.

Note however that chaff/flare dispensers cannot be deployed at less than 3 second intervals.

RUSSIAN ALPHABET

Russian character	Pronunciation	English equivalent
А	[a]	A
Б	[b]	B
В	[v]	V
Г	[g]	G
Д	[d]	D
Е	[je]	E
Ё	[jo]	-
ж	[zh]	-
З	[z]	Z
И	[i]	I
Й	[j]	-
К	[k]	K
Л	[l]	L
М	[m]	M
Н	[n]	N
О	[o]	O
П	[p]	P
Р	[r]	R
С	[s]	S
Т	[t]	T
У	[u]	U
Ф	[f]	F
Х	[kh]	H
Ц	[ts]	-
Ч	[ch]	-
Ш	[sh]	-
Щ	[sch]	-
Ъ	-	-
Ы	[i]	Y
Ь	-	-
	[e]	-
Ю	[ju]	-

GLOSSARY

AAA - Anti-Aircraft Artillery.

AAM - Air-to-Air missile.

Active Jamming Indicator - This indicator illuminates when the built-in and/or additional Sorbtsiya active jamming system is engaged.

ACS - Automatic Control System.

ADI - Altitude Direction Indicator.

Afterburner Engaged Indicators - These indicators become illuminated when the RPM for the engines exceed 100%.

AGM - Air-to Ground Missile.

AI - Artificial Intelligence.

AIM - Air-Intercept Missile

Aiming Reticle - An indicator on the HUD that shows the general path of the weaponary.

Airbrake - The large panel that can be extended to create resistance against airflow to reduce airspeed and aid in manoeuvres and landings.

Aircraft Datum - Located in the center of the HUD, this display represents a silhouette of the aircraft which shows the orientation of the aircraft relative to the Horizon.

Airgroup- A group of aircraft that can be can consist of any number of Wings all performing the same sortie.

Airspeed - The velocity of the aircraft in relation to the surrounding air.

Airspeed Indicator/Mach Meter (ASI) - This indicates the current airspeed and mach number.

Altitude Direction Indicator (ADI) - This is the main navigational instrument. It shows the aircraft's spatial orientation in relation to the horizon.

Altitude Indicator - Located in the upper right of the HUD, this indicator displays the aircraft's barometric altitude or Radar Altimeter altitude.

Altitude Stabilisation - The mode of ACS that maintains the plane at the same barometric altitude.

Altitude Stabilisation Indicator - Indicates whether or not the Altitude Stabilisation is engaged.

Angle of Attack (AOA) - This is the vertical difference between the trajectory or flight path and the direction the plane is pointing or pitch angle.

Anti-Radiation Missile - A missile that homes in on the radio frequency radiation produced by radar.

AOA - Angle of Attack.

AOA Indicator - The AOA indicator shows the operation angle of attack.

APC - Armored Personnel Carrier.

ASI - Airspeed Indicator Mach Meter.

Automatic Control System (ACS) - When engaged these modes of flight take control of many of the necessary input functions a pilot must do. Also called Autopilot.

Automatic Control System Failure Indicator - Illumination indicates malfunction of the Autopilot or Altitude Stabilisation modes of the ACS.

Automatic Landing - Engaging the Autopilot and switching to Return Mode will navigate the plane to the approach beacon, and switch to Landing Mode.

Autopilot - The mode of ACS that computes the flight parameters of the flight plan and generates control inputs accordingly.

Autopilot Engaged Indicator - When lit the Autopilot portion of the ACS is engaged.

AWACS - Airborne Warning and Control System.

Bank Scale - Located in the center of the HUD, this half-circle indicates the degree of the aircraft's bank.

Barometric Altimeter - This indicates the altitude which is based on the difference between outside air pressure and air pressure at sea level.

Beyond-Visual-Range Mode (BVR) - This mode is a display of the Multi-Function Display (MFD) which shows targeting information on enemy, friendly, and unknown aircraft taken from radar and/or AWACS aircraft.

Bore - Boresight - An instrument mode that slaves the aircraft's sensors to a concentrated spot.

BVR - Beyond - Visual-Range Mode.

BVR – AWACS - AWACS Datalink

BVR - SCAN – Scans multiple contacts at BVR ranges.

BVR – TWS – Tracks multiple contacts while scanning others at BVR ranges.

CAC- Close Air Combat Mode.

CAC – BORE - Boresight Submode

CAC - HMTD - Helmet Mounted Targeting System

CAC – VS - Vertical Scan Submode.

CAP - Combat Air Patrol.

CAS - Close Air Support.

Canopy - The transparent enclosure around the cockpit of the aircraft.

CBU - Cluster Bomb Unit.

CCIP - Continuously Computed Impact Point. An indicator of this point will appear on your HUD.

Chaff - Radar countermeasure that uses tiny metal strips.

Chaff/Flare Counter - This counter displays how many APP50 combined chaff and flare dispensers remain at your disposal.

Chase View - A view of the current flying object from an imaginary chase plane.

Chase+ View - It is similar to the Chase View but when a missile or rocket is launched the camera tracks that projectile until it detonates and then it returns to the Chase View of the object previously selected. F7

Close Air Support (CAS) - A combat task which involves actively searching for enemy ground targets on the battlefield and destroying them.

Closure Rate - The rate at which one aircraft is approaching another.

Cockpit View - The default view of the instrument panel from within the Flanker.

Combat Air Patrol (CAP) - A patrol designed to defend a relatively small area of airspace.

Configuration Display - This displays the status of the landing gear, flaps, anti-FOD screens, and air brake.

Dogfight - An air-to-air engagement, often occurring at close range.

Drag - The airplane's resistance to forward momentum as it travels through the air.

Drogue Chute - A set of chutes that can be deployed by the Su-27 to slow down on landing.

ECM - Electronic Countermeasures. A Sorbtsiya pod carried on the Flanker can be used to produce electromagnetic waves to jam or confuse enemy sensors.

ENR – Enroute Navigation Mode.

EOS - Electronic Optical System.

Flaperons - The trailing edge of each wing that allows the aircraft to roll, or create extra lift and drag for takeoff and landings.

Flares - A countermeasure used to confuse enemy IR missiles.

Flight Path - The trajectory of flight regardless of the pitch angle, slip, or the direction in which the plane is pointing.

Fuel Gauge - This gauge indicates the total fuel remaining in the tanks.

G - The force of gravity.

G-meter - This indicator shows the Gs scale and the positive and negative Gs you are currently pulling.

GBU - Guided Bomb Unit.

Gimbal Limit - The area in which a sensor can work.

GRND - Air-to-Ground Mode

Ground View - A view of the current AAA, SAM, or EWR station.

Gunnery Target Funnel - An element of the HUD used with the cannon in air-to-air combat. See Chapter 6 for more information.

Head Up Display (HUD) - The transparent multi-function display located directly in front of the pilot.

Heading Scale - Located in the top of the HUD, this indicator displays the bearing in degrees.

Helmet Mode - A combat mode in the Flanker, utilising the sensor on the pilot's helmet.

Horizontal Situation Indicator (HSI) - This navigational instrument allows the pilot to determine the heading of the plane, heading towards a way point, vertical deviation from a glide path, offset from runway centerline, and influence of wind that causes slip.

HIS - Horizontal Situation Indicator.

HUD Mode Indicator - Located in the lower left of the HUD, this displays the navigation or combat mode you are using.

Hydraulic Systems Failure Indicators - Illumination means a failure of the Hydraulic System occurred.

IFF - Identification Friend or Foe.

ILS - Instrument Landing System

Instrument Landing System (ILS) - An airfield with this system projects radio beams at the approach trajectory to show deviation information from the approved glide path.

IR - Infrared. Usually referring to sensors on missiles and aircraft.

Jet Pipe Temperature Indicators - These indicators show the exhaust temperature for both of the AL31F engines.

LERX - Leading-edge root extensions. These allow a plane to generate lift forward of the center of gravity which increases agility in a pitch.

Lift - The force an airplane wing creates by causing the air pressure above the wing to be less than the pressure below the wing.

LMA - Longitudinal Missile Aiming Mode; uses the weapon's seeker to acquire the target.

LNDG – Landing Navigation Mode.

LSO - Landing Signal Officer.

Mach 1 - The speed of sound at sea level.

Magnetic Compass - The cockpit canopy houses the ball compass, which indicates the heading in 30∞ increments.

Master Warning and Failure Indicators - These indicators alert the pilot about hazardous situations and system failures such as ground proximity, low fuel, illumination of your aircraft, radar failure, Electro-Optical System failure, and Radar Warning System failure.

Maximum Engine Temperature Indicators - When illuminated these warn the pilot of critical jet pipe temperatures as a result of engine failure, fire, compressor failure, or missile strike.

MFD - Multi-Function Display.

Military Power - 100% thrust (as seen on the RPM gauge).

MiG - An aircraft built by Military Industrial Group.

Multi-Function Display (MFD) - Displays information depending on the current mode. Modes include Navigation mode, Beyond-visual-range mode (BVR), Close Air Combat mode (CAC), and Track mode.

NAV – Piloting navigation mode.

Navigation Mode - This mode is a display of the Multi-Function Display (MFD) which shows your plane (as a small triangle) in relation to the way-points which are connected as a polygonal line.

Neutral Trim Indicator - When illuminated, this indicator means the trimmer is in the center or neutral position.

On-Route Mode - This navigation mode aids the pilot in following his flight path by displaying the route information.

Outside View - A view of the current aircraft from some remote point which moves along with that aircraft.

Outside+ View - Similar to the Outside View but when a missile or rocket is launched the camera tracks the projectile until it detonates and then returns to the outside view of the object previously selected.

Padlock System - This allows your view to "lock on" to the target while manoeuvreing.

Pitot Head - The front-most part of the aircraft radome.

Piloting Mode - This is a sub-mode of the Navigation Mode. This mode can be used when you don't need to follow a specific flight plan.

Pitch Angle - This is the vertical angle between where the plane is pointing and the horizon.

Radar - Radio Detection and Ranging

Radar Altimeter - This indicates the aircraft's altitude in meters above the ground

Radome - The cone located in the front-most part of the aircraft.

Redout - A loss of vision due to pulling to many negative Gs.

Return Mode - This sub-mode of the Navigation Mode aids the pilot in positioning the aircraft for approach and landing on a selected airfield.

Rockeye - A type of American cluster bomb.

RPM Indicators - These gauges display the RPM in percentage for both starboard and port engine thrusts.

RTN – Return Navigation Mode

Rudders - The rudders pivot along the trailing edge of the tailfins which allows the plane to yaw left or right.

SAM - Surface to Air Missile.

SARH - Semi-Active Radar Homing. Ordnance that requires that the target be locked onto by radar until impact.

Ship View - A view of the current ship from a particular remote point.

Slats - The leading edges of the wings that automatically adjust for manoeuvres, takeoffs, and landings.

Slip Angle - The horizontal difference between the trajectory or flight path and the direction the plane is actually pointing, including yaw.

Static Objects - Units that will have no AI attached to them.

Su - An aircraft built by Aviation Military Industrial Group Sukhoi

Tailcone - The long projection from the aft between the engines that reduces drag and houses the drougue chute, antenna, and 32 chaff/flare dispensers.

Tailerons - These stabilisers are located at the rear of the aircraft to the left and right of the engine nacelles and allow you to pitch up or down.

Target - A target is a friendly or enemy aircraft that is locked and being tracked.

Target Designator Box - An indicator that appears on the HUD which can be used to change the status of contacts.

Task - The particular function that an aircraft is supposed to perform in a mission. See Chapter 12 for more information.

Threat Warning Display (TWD) - This gauge depicts information on enemy illumination sources, radar installations, and AWACS.

Thrust - The force that propels an aircraft through the air. The Su-27's twin AL-31F turbofans give 25000 kg of thrust in afterburner and 15200 kg in military power.

Track While Scan Mode - This mode is a display of the Multi-Function Display (MFD) which shows the radar or EOS information on the target.

Trimming - This adjustment allows you to adjust the plane so it can fly level with the joystick centered at most altitudes or speeds.

True Airspeed - Located in the upper left of the HUD, this indicator displays the speed of the plane in relation to the air it moves through.

TWD - Threat Warning Display.

TWS - Track While Scan.

Variometer - This indicator displays the rate of climb, rate of turn, and rate of slip.

Waypoint - A location along an aircraft's route where an action takes place.

Weapons Readiness Panel - This Indicator shows the locations of the available weapons hanging on 10 under-wing and fuselage pylons.

Wing - One to four aircraft within an Airgroup, all of which are performing the same task.

Yaw - The turning of an aircraft caused by moving the rudders right or left.

БВБ-ВС – See "CAC – VS"

БВБ-СТР – See "CAC – BORE"

ВОЗВ – See "Rtn"

ДВБ – See "Beyond Visual Range Mode"

ДВБ – **ОБЗ** – See "BVR - Scan"

ДВБ – **СНП** – See "BVR – TWS"

ДВБ – **ДРЛО** – See "BVR – AWACS"

ЗЕМЛЯ – See "GRND"

МАРШ – See "Enr"

НАВ – See "Nav"

ПОС – See "Lndg"

ФИО – See "LMA"

РЛС - ("RLS") Radar Failure

ОЛС -("OLS") Electro-Optical System Failure

ПУСК - ("PUSK") Missile Launch Warning

СПО - ("SPO") Radar Warning System Failure

СПП - ("SPP") Missile Launch Warning System failure

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Please be as specific as you can be about the problem you are experiencing. Also include in the body of your e-mail: the name of the manufacturer of your computer system; the brand and speed of the processor; how much RAM you have, the version number of Windows you are using (if you aren't sure, right-click on the My Computer icon on your desktop and select 'Properties'), and the manufacturer name and model number of your video card, modem, and sound card.

Other Support Options

You can also contact Ubi Soft Customer Support by phone and fax. When you call, please have all of the above mentioned information ready.

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